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SIR CHARLES WHEATSTONE, F.R.S.

IN the death of Sir Charles Wheatstone the world has lost one whose ingenuity, sagacity, and skill were devoted to the practical application and development of ideas which had for many years been floating about the world without effecting any service to mankind. The faculty of invention is frequently, and, indeed, generally separate from that of utilization. In him both were combined, and the combination not only augmented his powers but brought him riches and honour.

The communication of intelligence by electricity does not appear to have passed beyond the brain of electricians until about the middle of the last century (1748), when Watson found that he could carry the fluid to 600 yards and give a shock; and soon after a gentleman of Renfrew wrote to the "Scots' Magazine," 1753, a letter on "An Expeditious Method of Conveying Intelligence," in which, after reciting the previous labours of others, he says, "Let, then, a set of words equal in number to the letters of the alphabet be extended horizontally between two given places and . . . . . at the end of these wires balls should be suspended against a glass sheet, and the wires striking the glass these balls would drop upon an alphabet arranged upon the table, and thus, by a spelling method, communication could be made of words." He added a suggestion that the wires be covered with jewellers' cement to prevent the escape of the electric fluid; and another, that bells might be substituted for balls. This is the earliest and only record we have of the beginning of electric telegraphy. A Genevese, M. Lesage, has the honour of having established, in practice, the first telegraph wire for the transmission of electric signals, realizing the idea of the Scotchman above named, but he had twenty-four wires (the alphabet) connected at the further end by a separate pith-ball electroscope. Thus by frictional electricity (the common form) these pith-balls at the end moved at the will of the sender; but the difficulty he had arose from the obvious necessity that these balls should resume their quiescence because the air

soon became charged with matter interfering with so delicate an operation. In 1787 Lemond made the like discovery, apparently ignorant of his predecessor, but he used only one wire. He added a combination of signals, and found that the length of wire did not interfere with the certainty or correctness of the message he would communicate. This addition stimulated others to investigation, and it was soon found that common electricity could not yield a satisfactory result. The last and most ingenious invention of a telegraph worked by frictional electricity was that of Mr. Ronalds of Hammersmith, in 1823. He erected a line in his garden eight miles long, insulated by silk and dry wood, and also buried a considerable length insulated in glass tubes, encased in pitch and wood in the earth. Mr. Highton describes it at length in his "The Electric Telegraph," and it is indeed a most meritorious construction, but it for ever settled the question, that until a new fluid were discovered or produced all the energy and scientific skill could not avail to produce a permanent public good. Ronald had wrought for seven years, and deserves very high respect for such devotedness—a devotedness by no means uncommon among scientific men, but one which the world more often despises than rewards.

Meanwhile the celebrated Galvani had, through his wife's observations, accidentally discovered by phenomenon the existence of what we call Galvanic electricity, but not being a scientific man he blundered in his theory, which brought up Alexander Volta of Pisa, who overthrew many of his arguments in what became a very acrimonious controversy, yielding little or no profit to their generation.

In 1809 Œrsted made the important discovery that a magnetic needle always tends to place itself at right angles to an adjoining wire through which an electric current from a galvanic battery is passing, and in 1820 Ampère enunciated a plan for an electric telegraph on this basis. This principle was the one subsequently used by Professor Wheatstone in all his needle telegraphs, and therefore to Ampère, who first proposed the use and combination of the magnetic needle—the coil of wire—and the galvanic battery, is due the credit of first publication of the practicability of such an instrument. Ampère used as many needles as there were letters; Wheatstone made a combination by which five wires could give twenty words. Experiments for some few years turned upon machinery and instruments, but indirect discoveries were quietly made and studies pursued bearing on the currents and matter, which really was the most formidable difficulty. Ampère's system failed because of the number of his wires. In 1832 Baron Schilling Von Cronstadt made two telegraphs which he exhibited to the Emperors of Russia, Alexander I. and Nicholas, one of which had five needles and the other one, but death intervened and prevented him bringing his work to a public test.

Mr. Wheatstone, who was born at Gloucester in the year 1802, adopted the manufacture of musical instruments for his calling in life, and gave early indications of his capacity for applying the results of scientific investigation to the enlargement of that branch of production. What others had learned from their study of electricity he learned from the laws of sound, namely, that at the will of one person different sounds could be reproduced in distant places through solid wires. This was in 1823. He pursued his studies and soon became acquainted with Faraday; through him in 1827 he communicated a paper to the Royal Society entitled "Description of the Kaleidophone, or Phonic Kaleidoscope; a new philosophical Toy for the illustration of several interesting and Amusing Acoustical and Optical Phenomena." This was one of the many efforts of his inventive mind. Under the guise of amusement he produced observations which led him to the knowledge of analogy between the laws of sound and those of electricity, and the further investigations which the study and experiment suggested led him to the theory and practicability of the electric telegraph. In the following year he, through the same friend, communicated a paper, "On the Resonances or Reciprocated Vibrations of Columns of Air," in which he investigates the laws of the resonance or phonic reciprocation of columns of air, instancing, as his illustrations, the effect of certain combinations of tuning-fork and flute; again, the accord of flutes in harmony and the dissonance when one is drawn out to the half tone, showing the feebleness and the law thereof. He then illustrates his subject further by an explanation and drawing of the *Gènder*, a musical instrument of Java (now in the Indian Museum), the sound of which is produced from metallic plates and the notes elicited by bamboo. He then explains the laws of sound as they are seen in the Jew's harp, and ends by a philosophic direction as to the calculations and the results of the data supplied or which may be created.

On the 9th May, 1828, Mr. Faraday communicated to the Royal Society another paper by Mr. Wheatstone on the "Nature of Musical Sounds, how produced, and by what law, and how and by what law sustained," quoting previous experiments and describing some curious musical instruments invented by M. Cagniard de la Tour, which could derive its sound from either air or water. He then refers to the new German invention, with which he afterwards became so especially identified, the accordion. He has been accredited with being the inventor, but his paper affords contrary evidence. His life continually found its work in applying beneficial discoveries to public service, and in that work he has scarcely a parallel. His own description in his patent shows his claim, "Improvements in the construction of wind musical instruments; which improvements are applicable to instruments producing sounds by directing a current of air against metallic springs or tongues fitted over and vibrating freely within or over corresponding apertures formed in plates. . . . These constitute one of the simplest forms of a wind musical instrument known in Germany by the name of Mundharmonica, and in England by that of Æolina. Finger keys are added somewhat similar to those in flutes . . . at distances to allow space for the fingers to apply themselves to each key when the instruments are held in such positions as for the hands to be used as in fingering the flute or flageolet." He then describes further improvements as to the springs, the wind-chest, and also that form in which wind is superseded by portable bellows.[1]

Wheatstone deserves here the credit of invention because of the varied power of adapting a known principle.

The trade and manufacture of musical instruments continued to be his main business, and in 1836 he brought out "a new method of forming musical instruments, in which continuous sounds are produced from strings, wires, or springs," by means of "a current of air directed upon a limited portion of the vibrating length. 'Continuous' means the maintenance of sound so long as the exciting cause is sustained, in contradistinction to abrupt and evanescent sounds as those of the piano or harp. The vibrating string, wire, or spring must be adapted to a slit or aperture through which the current passes." He then describes various methods of producing these sounds, and follows with improvements in "hammering," and after enumerating other methods ends by inventing an adapted bellows. This patent applies to all the family of accordions up to the organ accordion,[2] and is simply an improvement upon the former one.

In 1844 he patented "Improvements on the Concertina and other musical instruments" of the class, consisting of the addition of reeds, which he called "an Eolian attachment," to the bottom of the case of an ordinary pianoforte, without interfering with the construction of the instrument; and a further improvement, by which the reed tone is incorporated with that of the piano, and when desired is capable of producing the sound called "tremulo."[3] All these patents have drawings attached.

In 1860 he patented his "telephone," by which sounds can be communicated by electric telegraphy by an alphabet of twenty-four sounds, three octaves.[4]

We owe to the enterprising genius of Michael Faraday the two discoveries not less important in physics than useful in relation to the telegraph—volta-electric induction and magneto-electricity,[5] discoveries not made by chance, as was that of Galvani, but, as he describes in his "Experimental Researches," the results of profound consideration, in which he gleaned from all his friends what facts they could supply, and, with a certain conviction as to the issue, set to work to demonstrate the process. As is well known, Faraday published all his results immediately he had reached them, and consequently practical men had the advantage or opportunity of using his labours to the public gain. These two discoveries excited the ingenious everywhere to overcome the constructive difficulties now that a new fluid, so long desired, was placed at their command, as he himself had, as he says, been stimulated to his investigations by the researches of Arago in magnetic phenomena. He began in 1831 and continued in the following years. In 1833 Schilling's idea of giving signals by a single needle was submitted to a practical test by Gauss and Weber, of Gottingen, who first employed Faraday's discovery in the service of telegraphy by erecting a double-wire line of copper over the houses from the Physical Cabinet to the Magnetic Observatory, and showed the absolute control of the manipulator, and according to the report made it clear "that it would be possible to arrange an uninterrupted telegraphic communication in the same way between two places many miles distant from each other." These experiments were not, however, intended for the study of telegraphy, but as physicists to institute inquiries into the intensity of galvanic currents on a large scale. These gentlemen, perceiving the brilliant results possible, and

[1] Newton's "London Journal," vol. ix.
[2] Patent, No. 7,154. 1836.
[3] Patent, No. 10,041. 1844.
[4] Patent, No. 2,460. 1860.
[5] Sabine's "History of the Telegraph."

having no leisure to take up that department, requested Professor Steinheil, of Munich, to simplify the apparatus and endow it with a practical application. His labour gave him really more claim to the invention than his friends who communicated the primal ideas. He erected aerial lines of various lengths, from 1½ to 8 miles, and by further experiments upon the railway metals discovered that the earth could be enlisted in the service, and in fact was the best and safest depository.

We see that no one can make an absolute claim to the "invention," but if there be one who deserves more credit than others for energy, intelligence, and success herein, it is Professor Steinheil. He has had many imitators who have taken out patents, but none have improved on his simpler ideas.

Wheatstone availed himself of Faraday's discovery, with whom, as we have seen, he was very intimate, and his researches on the velocity of the electric wave in solid conductors directed his attention to telegraphy, making known to his scientific friends his progress from time to time, but taking out no patents. In answer to such solicitations he had made arrangements with the manager of the Birmingham line to make a trial, but the incessant demand on his time in scientific and mechanical studies prevented him. Mr. W. Fothergill Cooke, who had retired from the Indian army and had come to the Continent for the purpose of qualifying himself for the medical profession, entered into arrangements with Dr. Moncke, at Munich, to that end. That gentleman had watched the course of science, and in his laboratory constructed many odds and ends which he explained to Mr. Cooke, whose genius instantly caught at the prospect they unfolded. He abandoned medicine, and gave his mind to the application of the existing knowledge and instruments for railway telegraphy, and came over to England with introductions to Faraday and Roget. These eminent men sent him on to Wheatstone as the Englishman who had gone farther than any in those studies. Cooke obtained consent from the Birmingham railway authorities to make an experiment as far as to Hitchin, and he seems to have done this rather covertly with a view to undermine Wheatstone, who had candidly informed him of all he knew and had done. However, Wheatstone, having no leisure for the outdoor work of construction and the indoor work of a factory, met the matter by entering into partnership in a patent or patents. Cooke possessed good knowledge, ingenuity, patience, and application, and the wire was bought and set up, and the instruments tested with success. That the work was really Wheatstone's, although he could not have done it, there is no doubt, and so it was held and regarded by all concerned at the time. The account for wire was sent to Wheatstone, and to Wheatstone the report and compliments concerning the test were addressed. Mr. Cooke appears to have been rather unreasonably jealous, and somewhat narrow-minded, and claimed the invention; a vexatious hubbub followed because Wheatstone was receiving honour and public recognition as the general benefactor; this was resented by Mr. Cooke and his friends in a pamphlet not distinguished for its courtesy. After a year Wheatstone broke silence by a reply, which is practically unassailable. We quote in a free and condensed form the essence of it.

"I believe that on the 1st of March, 1837, Mr. Cooke introduced himself to me. He had told me that he had applied to Dr. Faraday and Dr. Roget for some information relative to a subject on which he was engaged, and that they had referred him to me as having the means of answering his inquiries: he gave me no clue as to the purpose he had in hand. I replied that he was welcome to any information I could give him, and that the experiments I had been making for some time relative to employing electric currents for the purpose of telegraphic communication would enable me to give him much of the information he required. At our next meeting, very shortly afterwards, he told me he was also working at an electric telegraph, and that the questions he had put to me previously related to this subject, but said nothing respecting the nature of his experiments. I showed him my keyboard and mentioned my proposal for ringing an alarum by means of the electro-magnet and other things, and invited him to the college to see my experiments in action. All this occurred before Mr. Cooke communicated to me anything he had done.

"Although Mr. Cooke showed me some of his drawings and models, and . . . I told him that it would not and could not act as a telegraph, because attractive power could not be imparted. . . . He came to King's College and saw my works, and he expressed his disappointment in these words, 'Here is two years' labour wasted.'"

Sir Charles Wheatstone complains, in 1840, of the persistent efforts of Mr. Cooke to claim the invention of the Telegraph as a public communicator, which claim, having at last been made in print, produced from him a remonstrance which substantially is not at all impugned by the reply. We make extracts for two purposes: first, because it explains the means of producing practical results, and secondly, because it contains his own vindication.

After repudiating and disowning any connection with certain newspaper paragraphs in his praise, Sir Charles proceeds calmly to give his own answers and make his own explanations.

"Firstly, you state that you alone had succeeded in reducing to practical usefulness the Electric Telegraph at the time you sought my assistance. This I wholly deny. Your instrument had never been practically applied, and was incapable of being so. Mine were all founded on principles which I had previously proved by decisive experiments would produce the required effects at great distances.

"Your statement that I employed myself at your request in perfecting your invention in detail is equally erroneous. My time, so far as it was devoted to telegraphic researches, was exclusively occupied in perfecting my own instrument, which had nothing in common with yours, and in which I was not only known to be engaged by all my scientific friends but which was even announced in public print before I knew of your existence. I confined myself to carrying out one of my own inventions for two reasons: first, because my experiments led me to believe that the motions of a needle could be produced at distances at which no effects of electro-magnetic attraction could be obtained; and secondly, I did not wish to interfere with you. With regard to the subsequent development of my first telegraph, the essential principles of which are the formation of numerous circuits from a few wires and the indication of characters by the convergence of needles, I am indebted to no person whatever; it is in all its parts entirely and exclusively my own. The modifications you introduced without consulting me in the instruments for the Great Western Railway altered the simplicity and elegance of the arrangement without the slightest advantage, and I certainly should not recognize them in any published description.

"When I made, in 1823, my important discovery that sounds of all kinds might be transmitted perfectly and powerfully through solid wires, and reproduced at distant places, I thought I had the most efficient and economical means of establishing a telegraphic or rather a telephonic communication between two remote points that could be thought of. My ideas respecting establishing a communication of this kind between London and Edinburgh, you will find in the 'Journal of the Royal Institution' for 1828. Experiments showed me that the velocity of sound could not overcome the resistances and enable it to be transmitted efficiently through long lengths of wire. I then turned my attention to electricity as the communicating agent. The experiments of Ronald and others had made no impression on the scientific world, because so little was known of the velocity and other properties of electricity . . . I undertook the inquiry, and with the result the whole scientific world is acquainted . . my experiments on several miles of wire were witnessed by the most eminent philosophers of Europe and America. I ascertained experimentally (which had never been done before) many of the conditions necessary for the production of the various magnetic, mechanical, and chemical effects in very long circuits; and I devised a variety of instruments by which telegraphic communication should be realized on those principles.

"The circumstances under which your name was allowed to take the lead in the titles of the British patents have escaped your memory: I will endeavour to recall them to you. When you first proposed partnership you know how strongly I opposed it, and on what grounds. I said I was perfectly confident of being able to carry out my views to the end I anticipated, that I fully intended doing so, and publish the results, then to allow any person to carry them into practical effect. I told you that, while I admired the ingenuity of your contrivance, I deemed it inapplicable to the purpose proposed, and I urged, that in the position I held the association of my name with that of others would diminish the credit I should obtain by separately publishing the result of my researches. You replied, that you were not seeking scientific reputation, and therefore no difference could arise between us on that account, and that your sole object was to carry the project to profitable execution. A patent was arranged to be taken out in our joint names which should include our two separate instruments. When we met to settle the preliminaries for the English patent, I was much surprised to find your name inserted first, considering that, as we put ourselves on an equality by each contributing an invention, to put my well-known name after yours, then totally unknown, might be construed into an admission of the superiority of your share. You urged that your pecuniary obligations were the greater, and that, as I intended to leave negotiations with you, your authority might be less respected if your name appeared second, and that your invention was the more valuable; an assumption I did not admit, and the event proved I was right.

But we agreed that in subsequent patents the order should alternate. Some time after we met to settle the Scotch patent draft, for which you had prepared the declaration. I was again surprised to find the same order of precedence repeated, and I objected to it as contrary to our previous understanding. You said it had been done without your knowledge, but objected to the alteration on the ground of delay. After discussion we made a new arrangement, that on my allowing your name to stand on the British patents mine should take the lead in all foreign ones. It was resolved afterwards that an American patent should be obtained and when I attended to sign the preliminary papers I found that again without any notice to me my name was made to follow yours . . . I refused to sign the papers, and you then consented to keep your word. *The only reason you alleged* was that your authority as manager would be diminished if you appeared as second partner."

Mr. Wheatstone then narrates that his subsequent observations showed him the defects, and that in the course of new experiments he kept Mr. Cooke in full knowledge of the results ; but, finding him always putting hindrances and helping nothing, which naturally hurt him, he resolved to pursue his investigations alone, which resulted in a new patent in their joint names, reserving to himself, by consent, certain new instruments which did not depend on electro-magnetic attraction.

"When I had attained some complete results, I invited you to the college to see them, and, before describing or showing the new experiments and instruments, I proposed conditions :— That having, at my own expense, undertaken a series of investigations which led to important consequences, greatly increasing the pecuniary value of the patents, and having invented new instruments, which, besides being applicable to all the purposes for which the existing arrangements could be applied, might also be profitably applied to other purposes to which the previous instruments were not at all adapted, I required as a compensation . . . . that I should retain the exclusive right of manufacturing them and all instruments I should construct involving the same principles, and also the privilege of employing them exclusively for domestic and official purposes. To these conditions you assented, and afterwards I showed you the completed instruments, and read you a list of the further experiments ; you confirmed . . . . your assent. On this occasion you breathed not a word respecting the claim since put forward to be considered the joint inventor of my new instruments.

"You ask me to acknowledge 'that, I having certain improvements on our joint invention in progress depending fundamentally upon principles first discovered and applied by you . . . . had asked as a favour,' &c. It is unjust to urge such an acknowledgment upon me, and I state plainly that nothing shall compel me to make it. My instruments are original combinations involving a great number of points entirely new. With equal justice Mr. Ronald might call upon me to declare that he is the joint inventor, because, like him, I use a revolving dial with letters—or Professor Steinheil complain of my suppressing his name because, in one of my most important modifications, I employ, as he has done, the magneto-electric machine—as you to put forth that claim, because in some of my new instruments I have employed electro-magnetic attraction, which you had done before me in your instrument ; or with the same reason might Mr. Morse call upon me to proclaim him to be the joint-inventor because he, independently of you, has employed an electro-magnet to move machinery intended for a telegraph.

"One of your complaints is, that in the notices of my experiments in Belgium the employment of two wires for an electric telegraph was not specifically mentioned as a discovery of yours. Such a claim on your part has no foundation, for, without going further back, Ronald's two telegraphs—two telegraphs on different principles, which I myself proposed before I knew you, and Steinheil's telegraph, with which I was acquainted before yours. . . . . You forget that it is my electric telegraph, and not yours, that is in daily use. And, lastly, you forget that, had it not been for my exclusive attention to it since I first conceived the idea, a practical telegraph might have still remained an unaccomplished purpose.

"Do not, however, misunderstand me. Far be it from me to underrate your exertions ; they have been very great, and absolutely indispensable to the success of our joint undertaking. Without your zeal, and perseverance, and practical skill what has been done would not have been so readily effected ; but, on the other hand, I may say, that had you entered the field without me your zeal, perseverance, and money would have been thrown away."

This cannot be doubted. It is highly improbable that a raw student of medicine could from 1836 complete the subtle arrangements belonging to electric telegraphy in twelve months without gleaning nineteen-twentieths of his knowledge from others. That Mr. Cooke brought supreme energy, unoccupied time, vast concentration of idea to bear, and thereby was enabled to construct the field works of telegraphing to the public benefit is true, but he must be held to be the managing director of ideas not his own, and the user of instruments the work of others ; and this is no detraction, but the contrary. It, however, defines the position of the parties correctly. Professor Wheatstone received the honour of knighthood in 1868, and Mr. Cooke in 1869, so that both have obtained in proper sequence the distinction to which they were entitled.

The Telegraph Company followed the patent. That was begun by Wheatstone, Cooke, and Ricardo. Contracts were made, and the working of these fell to the lot of Cooke ; but all the private and office telegraphs were retained by Mr. Wheatstone ; from these great profits accrued and are accruing, and still the business of musical instrument construction and improvement proceeded successfully, and is now in working order at 20, Conduit Street, Bond Street.

It would fill this whole number to supply the details of the investigations, and to describe the infinite and intricately delicate improvements in telegraphy and sound which Wheatstone made to serve the pleasure and the progress of his generation ; but by-and-by, when the dust of the present is brushed away, he will ever be associated with such men as Faraday, as one of the brightest and clearest of scientific men, who endeavoured to make every atom of knowledge available to the common weal.

Wheatstone received his appointment as Professor of Experimental Philosophy in King's College, London, in 1835 ; was made a Juror at the Paris Exhibition in 1855, for "Heat, Light, and Electricity," and in the same year made an Associate of the Ordnance Committee at Woolwich, and subsequently became a member of several Government committees. He was a Foreign Associate for the French Academy of Sciences, and corresponding member of the Scientific Academies of Brussels, Munich, Gottingen, Stockholm, Rome, Turin, Modena, Milan, Edinburgh, Dublin, &c., and Chevalier of the Legion of Honour. He had the Copley medal, and two gold medals from the Royal Society, the X. L. gold medal of the Italian Society of Sciences, and the Prussian Order of Merit.

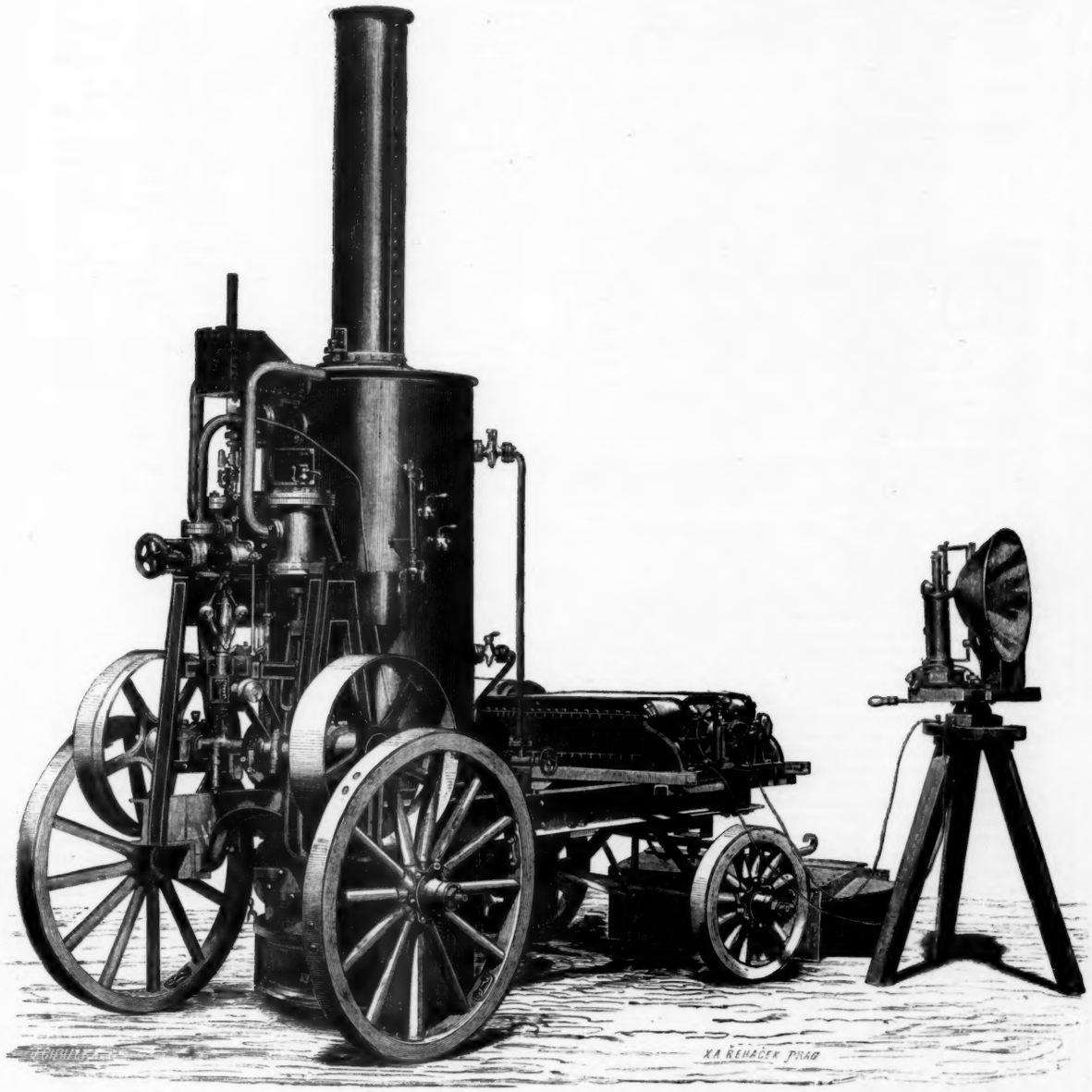
He left in his will all his scientific apparatus, medals, decorations, and scientific books to King's College, besides a sum of £500, to be devoted to scientific purposes, and his executor is Mr. Robert Sabine, his son-in-law, so well known for his book on the electric telegraph. The personal estate amounted to £70,000.

W. S. C.

LOCOMOTIVE MAGNETO-ELECTRIC INDUCTION ENGINE.

CONSTRUCTED AT THE SIEMENS-HALSKE TELEGRAPH WORKS, BERLIN.

WE reproduce from "Stummer's Ingénieur" the annexed representation of a locomotive magneto-electric induction engine, with electric light apparatus attached, constructed at the Siemens-Halske Telegraph Works at Berlin. It consists of a horizontal frame or carriage, running on four wheels, and adapted for horse-draught, the fore-part of which is occupied by a magneto-electric induction apparatus on the improved principle patented in Berlin by F. von Hefner Alteneck, in 1872, and subsequently, in England, by Dr. W. C. Siemens, in June, 1873, whilst the hinder part carries a small vertical steam-engine for driving the same. In the Hefner-Alteneck apparatus currents of electricity are induced in coils of insulated wire wound upon a metal drum, by causing the latter to rotate rapidly round an iron core placed between powerful magnets. The electric current can be conducted, either continuously or intermittently, to any desired point by means of conductors connected with the magnetic poles. When used for purposes of illumination and signalling, the conductors are led to an electric lamp, which is provided with a special arrangement for regulating the intensity of the current. The steam-boiler is vertical, made of steel-plate, with a fire-box suspended below; there are twin cylinders which set in motion a couple of driving wheels connected by means of belting (omitted in the figure), with the drum of the induction apparatus. These locomotives are made to any required size. In that shown in the illustration, which is taken from a photograph of one lately built, the engine works up to 200 revolutions per minute, producing 450 revolutions per



LOCOMOTIVE MAGNETO-ELECTRIC INDUCTION ENGINE.

minute of the drum of the induction apparatus. The latter is of thin German silver plate covered with eight separate coils of copper wire of 7 millimetres' gauge, and rotates between two very powerful horse-shoe magnets. Another regulator allows the speed of the drum to be adjusted at will. At full speed the electric current induced is sufficiently intense to heat a copper wire 1 millimetre in diameter and 12 metres long, to redness, and photometrically is equivalent to 14,000 wax candles. The draught of the engine with apparatus complete is 2,250 kilogs., or about 2½ tons.

THE SALITRE (NITRATE OF SODA) INDUSTRY IN SOUTH AMERICA.[1]

By M. P. L'Olivier.

THE existence of deposits of nitrate of soda in South America was first announced, in 1821, by Mariano de Rivero. No attempts were made to work them on any scale until some ten years later.

Native nitrate of soda, or *caliche*, is found in amorphous isolated masses, alternating with deposits of rock-salt and borate of lime, at altitudes of about 1,000 metres, all along the Pampa fringing the Pacific shore between latitudes 19° and 23°, 30° S.

For a long time the beds in the province of Tarapaca, Peru, only were known; but a few years since others were discovered in Bolivia, at Antoagasta in the south, and in the basin of the Loa in the north.

It is difficult to assign any precise epoch as the date of formation of these enormous deposits of alkaline nitrates; but my observations lead me unhesitatingly to attribute their production to the evaporation of salt lakes.

Slow evaporation would produce a deposit of successive layers of substances having a nitrate of soda base, such as is *caliche*. During this process of deposition the waters would gradually part with their nitrates, whilst a saline crust, richly impregnated with chloride of sodium, would form and remain suspended in the water. Subterranean movements, altering the configuration of the surface, must then have dried the lakes, separating the mother-water from the deposit formed in it. These are the *calicheras*. The saline crusts carried away by the water would accumulate against any obstacles they might encounter, and so form *salares* of little consistency. The evaporation of the water left in the depressions of the surface would produce other *salares*, richer and more compact than the former. Lastly, the surface waters from the Andes would bring down alluvium derived from older deposits, which would become impregnated and hardened by contact with the saline beds, forming the *costra* that is generally found overlying the *caliche*.

Westward of the *calicheras*, the *salares* are very abundant. About the mouth of the Loa I have found, in many places, masses of nearly pure salt; to the eastward, generally at high altitudes, are the deposits of borate of lime and boronatrocalcite, that are now being worked for the sake of the borax.

The relative thickness of the *caliche* and the overlying *costra* varies in different localities. In the province of Tarapaca, the *costra* is sometimes 3 to 5 ft. thick; in the basin of the Loa it is not more than 18 in., thinning out to 2 or 3 in. The thickness of the *caliche* varies from 1 ft. to 7 ft.

Besides earthy matter, the *caliche* contains a variety of saline substances, as will be seen from the subjoined analysis of samples from the Loa basin:—

	1.	2.	3.
Nitrate of soda . . .	51·50	49·05	18·60
Sulphate of soda . . .	8·99	9·02	16·64
Chloride of sodium . .	22·08	28·95	33·80
Chloride of potassium .	8·55	4·57	2·44
Chloride of magnesia .	0·43	1·25	1·62
Carbonate of lime . .	0·12	0·15	0·09
Silica and oxide of iron	0·90	2·80	3·00
Iodide of sodium . . .	„	traces	„
Insoluble matters . .	6·00	3·18	20·10

Sample No. 3, which may be classed as *caliche* of inferior quality, is, in point of fact, *costra*. The proportion of nitrate of soda varies. Some *caliches* contain 60 to 70 per cent., and I have met with it in the form of crystals.

[1] "Comptes Rendus Hebdomadaires," Oct. 1875.

The mineral is dug out, broken and washed, and yields about 95 to 96 per cent. pure.

For the old fashioned *paradas* (settling tanks) new *maquinas* of large size have been substituted, which will turn out 100 tons of *salitre* a day.

The *caliche* and the wash-water is steamed, and the concentrated solution passed into the crystallizing pans. At the Tarapaca Company's works the crystallization water is evaporated, and the saline residuum treated like *caliche*, in a *maquina* of smaller size.

In most establishments the refuse water from the last operation, which is rich in iodine, is treated for the extraction of the latter. The method of extraction is kept a secret. The Tarapaca Company's works alone produce 1,000 quintals annually.

The selling price of *salitre* or nitrate of soda ranges from 90 to 130 fr. per ton; that of the iodide from 3 fr. 25 c. to 4 fr. 50 c. per kilog.

It is estimated that last year there were in Peru 131 salitre works, 59 of them using improved apparatus. In full work they should yield 780,000 tons of nitrate; but the production has never exceeded 380,000 tons. Of this quantity France imported 47,873 tons in 1874, and 44,840 tons during the first eight months of 1875.

The duty levied by the Peruvian Government on the export of nitrate of soda, with the object of protecting the guano trade, is bringing about a crisis which will be with difficulty surmounted. Very soon, the *calicheras* of the Loa basin, in Bolivia, will alone be able to meet the increasing demands of the European market.

I think it may be interesting, in conclusion, to give an analysis of the water of the Rio Loa, which really differs but little from the subterranean water of the Pampas, on which the workpeople and the animals engaged in the workings are dependent.

In 100,000 parts I found:—

Chloride of sodium	228·3 parts.
Chloride of potassium . . .	22·0 „
Chloride of magnesia . . .	29·6 „
Chloride of calcium . . .	12·7 „
Carbonate of magnesia . . .	4·5 „
Sulphate of lime	77·0 „
Silica and iron oxide . . .	16·0 „
Nitrate of soda	traces
	390·1 parts.

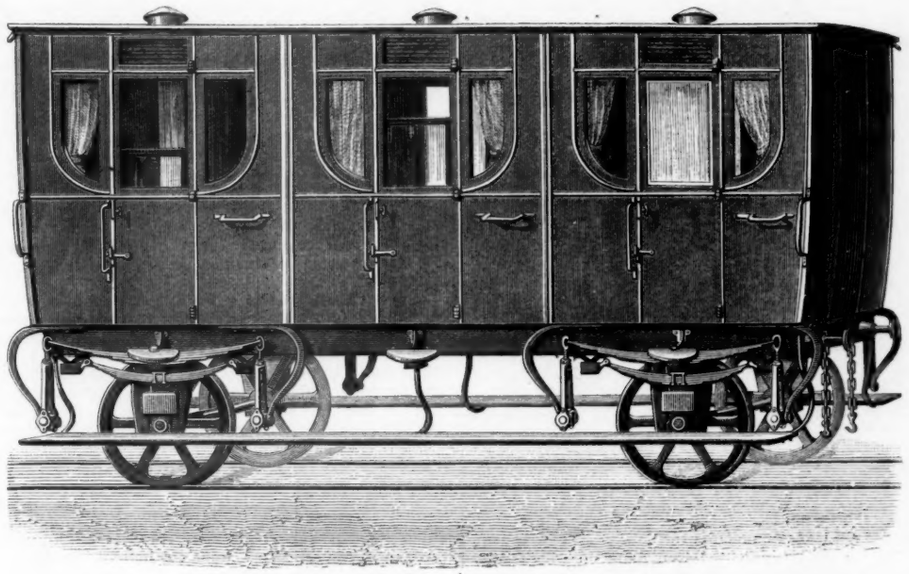
Giving about 3·901 grammes of fixed residuum per litre.

ECONOMY IN FUEL.

IN the presence of Mr. Bennock's utterance before the statistical section of the British Association at Bristol the other day, that "the waste of coal is a matter of everlasting disgrace to the genius of our country," any well-considered scheme, especially when reduced to practice, should be warmly welcomed.

M. Lagosse, of the Montgon Paper Mills, France, communicates to "La Métallurgie" an account of a process, devised by M. Charpentier, a Paris engineer, for the complete combustion of coal under a constant volume of burnt gases. After quoting the opinion of Péclet, that the draught of the chimney of a boiler furnace causes a loss equal to 25 per cent. of the fuel burnt, and speaking of the failure of smoke-consuming appliances on account of the cooling produced being more costly than the economy resulting from the consumption of smoke, M. Lagosse states that the apparatus under notice consists of a fan or blowing apparatus of some kind, a gas-producer for turning the fuel into gas, and a regenerator of the heat drawn along by the gases to the base of the chimney. The gas-producer may either form part of the firegrate or be separate from it, according to the arrangement of the boilers. The gases of combustion, intimately mixed with atmospheric air, are completely burnt without producing smoke; no cinders are made, and all the ashes even which fall between the grate-bars are again charged on the fire. Valves properly arranged permit of the regulation of the air which is admitted at certain points of the gas-producer; the stoker is therefore able at any moment to raise the pressure of steam, or, if it be preferred, to keep it at a uniform pressure. The damper, almost entirely closed, opposes the free dilatation of the gases; their heat remaining almost constant, they raise the feed-water in the regenerator to a temperature of 203° Fah.

M. Lagosse concludes by stating that, whereas under the old system of chimney he required two boilers, one of 40 and another of 50 horse-power fired hard, he now found that the 50 horse-power boiler was sufficient by itself, the power expended being rather greater, with an average saving in fuel of 20 per cent. In addition to this, he has substituted close-burning slack for semi-bituminous unscreened coal, and is burning up daily a portion of the cinders that have for years accumulated on the works. The apparatus takes but little time to erect, and involves no stoppage.



GIFFARD'S IMPROVED RAILWAY CARRIAGE.

IN our January number we gave a representation of a railway-carriage designed by M. Henry Giffard, with a view to obviate the rocking motion arising from imperfect suspension, to which all ordinary railway-carriages are subject. So far as absence of oscillating motion was concerned, the carriage was admitted to be a success; but the cost of construction was considerable, and the carriage itself exceedingly heavy.

The latter defect has been to a great extent remedied by M. Giffard, in an improved carriage, which has just been built by Chevallier, Cheilus, and Co., of Paris, and will shortly be tried on the Western of France Railway. As in the original model, the under-carriage and the body are perfectly distinct; but the suspensory arrangements are different. The carriage is supplied with ordinary springs connected by universal joints with curved iron supports on which the body rests. The weight is only 10 per cent. in excess of that of an ordinary first-class carriage. It is assumed that a very small extra charge would cover the cost of increased traction thus entailed.

TECHNICAL NOTES FROM SWITZERLAND.

ON the 6th of June last, the inhabitants of Rheinfalls and Schaffhausen celebrated the opening of their new waterworks by a public holiday. The plan of the works is simple and interesting. A double-action hydraulic engine at the foot of the falls raises the water from a spring close at hand, and drives it up to a reservoir situated 300 ft. above. The reservoir will hold 100,000 gallons. Thence the water is laid on by pipes as required; so that the inhabitants residing about the top of the falls enjoy a constant supply of the same excellent spring water as those at the bottom. The Arthur-Rigi Railway, opened on the 4th of June last, is worked as far as Oberrath, a distance of 1,395 metres, with ordinary locomotives. There the central cog-wheel system of locomotion begins, and the trains are pushed up the mountain side by engines from behind. These locomotives have horizontal boilers, like those on the Bitznau line, but differ from the latter in many respects, presenting various improvements. A triple system of brakes is in use:—1. A direct-action brake in charge of the conductor. 2. Another in charge of the engine-driver. 3. A compressed-air brake acting on the cog-wheel. The brake action can be supplemented by reversing the steam. The load for each locomotive is one large-sized passenger-car seating 42 persons, one small, seating 30 persons, and a parcels-van. No couplings are used.

From Oberrath the mountain line extends to a distance of 9,777 metres. The difference of level between the termini (Arth and Hulm) is 1,330 metres. The steepest gradient is at Klosterli station, 1 : 5; on the Bitznau line the maximum incline is 1 : 4. Unquestionably the most interesting portion to the practical engineer is the Kräbelwand section, a length of about 500 metres, where the line is carried along the face of the naked rock. The line has six bridges, one viaduct, and three tunnels, and must be regarded as a masterpiece of constructive skill, which reflects the highest credit upon the engineer, Simonett of Bündten.

In the borings for coal at Rheinfelden (Argau), a diamond-drill similar to those employed in the Mont Cenis and St. Gothard tunnels, but working vertically in place of horizontally, has come into use. The cutting is effected by fragments of diamond set round a stout iron ring fixed at the lower extremity of the boring-rod, which consists of iron cylinders, 6 to 8 centim. in diameter, screwed together in lengths. The drill rotates at the rate of 4 revolutions per second; the bored-out material, rising through the centre of the rods, shows the exact character of the strata passed through. The diamonds used are the black Brazilian, which are rather softer than the diamonds used for ornamental purposes. Under favourable circumstances the boring proceeds at the rate of 6 metres per day.

Bricks made of cement are now a good deal used in Switzerland. Not only are they cheap, but they offer other advantages besides. They weather better, are cleaner, and less liable to absorb organic impurities or moisture than others. The air in the rooms is therefore purer, and the rooms are more easily warmed, as there is no waste of heat by absorption on damp wall-surfaces, as in buildings constructed of more porous material. The work is laid very quickly too, so that houses can be run up very expeditiously, which, alone, is an important consideration. *Neue Deutsche Gewerbe-Zeitung, No.* 20, 1875.

A SOLAR STEAM-GENERATOR.[1]

MOUCHOT has communicated to the French Academy of Sciences some particulars of an apparatus devised by him for utilizing solar heat in industrial operations in suitable localities. It is a steam-generator, in which the sun's rays take the place of fuel, and consists of three parts :— a reflector, a steam-generator in the focus of the reflector, a glass cover. The following is a description of an apparatus of the kind which has been used, for experimental purposes, at Tours the last three years past :—

The reflector is a truncated cone of copper, with parallel ends, the larger 2·6 m. (108 in.), the smaller 1 m. (39 in.) in diameter. The sides form an angle of 45° with the axis. The interior is fitted with silver-plated annular reflectors, which can be removed as required for cleaning. It is solidly mounted on a cast-iron bed-plate, so as to lessen the effects of vibration produced by the wind. The same bed carries the steam-generator, which is formed of two concentric, cylindrical, bell-shaped envelopes of copper, the outer one 80 centim. (32 in.) high and 28 centim. (11 in.) in diameter, and blackened outside; the inner one 50 centim. (20 in. high) and 22 centim. (8 in.) in diameter. The annular space between the two, which is about 1 in. in breadth, serves as a boiler. Not more than 20 litres ($4\frac{1}{4}$ galls.) of water should be in the space at a time, so as to leave about half as much steam-room above it. The interior of the inner cylinder is left empty, and is connected with the steam-room between the envelopes. It serves therefore as a steam-chamber, whence the steam is conducted either to a cylinder or to an alembic, according to the object in view. The glass cover is an ordinary bell-glass 5 centim. (2 in.) larger every way than the generator, and 5 millm. ($\frac{2}{10}$ in.) thick. It admits of the passage of the luminous rays, but arrests the emission of obscure heat. In order that the apparatus may be accommodated to the diurnal and annual changes in the sun's position, the iron plate on which it is mounted rests on bearings in a revolving shaft. The shaft is placed in the plane of the meridian, and is inclined to the horizon at an angle equal to the latitude of the place. Suitable wheel-work is provided by which the movements of the bed-plate on its bearings, and of the shaft on its axis, can be regulated by hand. The former requires adjustment every half hour, the latter once every eight days. The following were the results obtained with the apparatus at Tours, in lat. N. 43° 27′ 47″. On 8th May, in ordinary fine weather, 20 litres of water, at a temperature of 20° C., were introduced in the generator at 8.30 A.M. After getting rid of the air, 40 minutes were required to get up a steam-pressure of 2 atmospheres, *i.e.*, 121°. The pressure rapidly rose to 5 atmospheres, a limit which it would be dangerous to exceed on account of the thinness of the walls of the generator. In the middle of the day, with 15 litres of water in the generator, steam of 100° attained a pressure of 5 atmospheres, *i.e.*, 153°, in 15 minutes. On 22nd July, about 1 P.M., on an exceptionally hot day, the apparatus converted water into steam at the rate of 5 litres of water per hour, corresponding to a supply of 140 litres of steam per minute. In the absence of a suitable motor, M. Mouchot employed at first an experimental engine without cut-off or condenser. With a constant pressure of 1 atmosphere a speed of 80 strokes a minute was kept up. The machine worked equally when the sky was overcast. A small Berlien's rotary engine was afterwards substituted, which was found to work admirably. By leading the steam to an alembic placed over a furnace, 5 litres of wine were distilled in 15 minutes. Vegetable, cattle food, &c., can be cooked quickly and in large quantities in this way. It was found that the highest winds had no injurious effect on the reflector; that the intensity of the heat utilized varied little between 7 and 8 A.M. and at noon, and that the glass was not subject to fracture by the changes of temperature to which it was exposed, and was hail-proof. M. La Bastie's discovery would now obviate any difficulty on the latter score. Large-sized apparatus has been found to give better results as compared with the area of heating surface than small.

In a subsequent communication to the Academy, M. Buchwalder calls attention to the immense antiquity of the metallic reflector in the shape of a rectangular cone, as a solar "concentrator." According to Plutarch, it was used for relighting the Vestal fires at Rome, in the days of Numa Pompilius.

M. Buchwalder also suggests that the solar "concentrator" might be used as a *refrigerator*, by substituting an ice-making maching, on the principle of M. Carré's, for the steam-generator.

[1] "Comptes Rendus Hebdomadaires," lxxxi. 14, 4 Oct., 1875.

INDUSTRIAL NOTES FROM THE EAST.

By Dr. J. E. Polak.

IN the East, cisterns and water-basins are to be found in nearly every house. Consequently there is a large consumption of cement, which is made in the following way. The ashes from the bath-houses—the bath-houses, it should be said, are heated with cow-dung, which contains a considerable percentage of silica—are mixed with fresh slaked lime, and pulp made from rushes. This mass is well stirred and beaten up together for several hours, and is then fit for use. In damp situations this makes an excellent cement. Where it is allowed to get dry, and especially where exposed to the action of frost, it is liable to crumble and is less suitable. In the East, as in Russia, the ashes from the baths supply sal-ammoniac. Anciently, this was the sole source of the supply; the substance being exported from Egypt under the appellation of *sel ammoniacum*—a name suggested by the oasis of Jupiter Ammon.

In hot climates a constant supply of pure cool water is a necessary of life, and water-coolers of porous earthenware, *alcazaras* as they are called in Spain, are in common use. In Persia, in Tunis, Morocco, Asia Minor, and the Caucasus, we find them. Specimens were sent to the late Vienna Exhibition, and are to be found in most museums. In Europe, the art of making these vessels appears to have been first practised by the Spaniards, and the Arabic origin of the name leaves little doubt that the manufacture was introduced in that country by the Moors. In Egypt, where, at the time of the overflowing of the Nile, the water becomes extremely turbid, it is customary to place it first in larger earthenware vessels, of the capacity of a Vienna *eimer* (about 15 galls. English) or more, where it undergoes a sort of process of deposition and filtration, trickling through a very small orifice at the bottom into smaller coolers (*alcazaras*). These, stood on the shady side of the house in the full draught of an open window, keep the water delicately cool and fresh. The water-jars manufactured at Kum, in Persia, are noted for the elegance of their shapes and their refrigerating powers. Smaller wares, which owe their porosity to an intermixture of rush-pulp with the clay, are made at Ispahan.

In the Persian court of the late Vienna Exhibition some beautiful samples of jute, of very fine and very long staple, were shown under the spurious name of *Canab* (Canabis). This species of *Corchorus* has been quite neglected in Persia. It grows abundantly on the marsh-lands about the Caspian, in the province of Mazanderan, where it is used in place of twine, and whence an unlimited supply could easily be procured by the Caspian route. The sparseness of the population, and the time-honoured manufacture and use of silk and woollen fabrics afford little hope of its utilization on the spot. For our present purpose it suffices to note the little-known fact—that jute grows abundantly and well in Persia. *Monatschrift für Orient, Oct.* 15, 1875.

UNIVERSAL CUTTING AND BORING MACHINE.

By Elterich, of Canstatt, Wurtemberg.

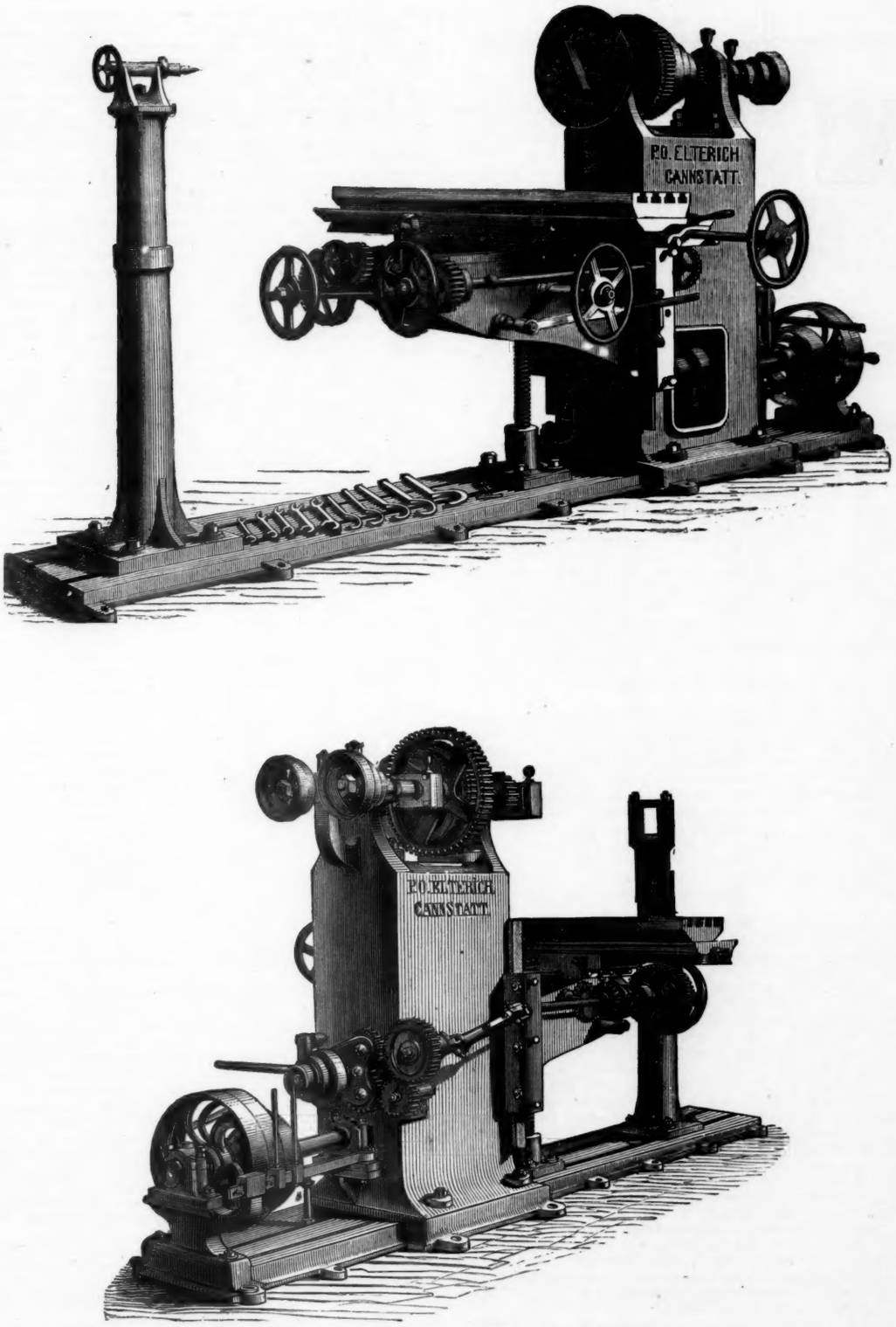
THE annexed figs. from the "Moniteur Indust. Belge" give side views of a cutting and boring machine of new design, by P. O. Elterich, of Canstatt. The machine, which is constructed in a very massive style, can be driven from either side, and is made in four different sizes.

The largest, which can be used for turning and centering blocks and wheels of 41 in. diameter, and for boring out steam-engine and pump cylinders up to 39 in. diameter, besides doing all the ordinary work of a cutting-engine, cutting screws, the teeth of cog-wheels, &c., has a travelling table admitting of a movement of 29 in. vertically, and 47 in. by 27 in. horizontally. Complete with all necessary tools and accessories, including transmission gear and the mechanism for the automatic movement of the table, it costs £270.

The next size has a lift of 19 in. and a horizontal movement of 25 in. by 18 in. Complete it costs £96.

The third size has the same lift and a horizontal adjustment of 15 in. by 11 in. It costs £70.

The smallest has a lift of 11 in. and a horizontal adjustment of 11 in. by 9 in. The price is £47.



UNIVERSAL CUTTING AND BORING MACHINE.

THE PROPOSED TRANSPORT OF CLEOPATRA'S NEEDLE TO ENGLAND.

ONCE again, during a period of seventy-four years, there is public talk concerning the possibility and desirability of bringing Cleopatra's Needle to England. What this needle is, where it is, and why English people are interested in it, are questions to be answered before we can understand the engineering and mechanical difficulties involved in the transport.

In the old days of Egypt, two obelisks were set up near Alexandria, each consisting of a single block of porphyry 60 or 70 ft. in height, 8 ft. square at the base, and tapering off to a point at the top. They are supposed to be two of four which Sesostris set up at Heliopolis, and to have been removed at a later date to Alexandria; they probably marked the entrance to a temple or palace. One of the four still remains at Heliopolis; one has been removed to the Piazza di Monte Citario at Rome; one is erect in position at Alexandria; the fourth is prostrate near it. There is no record of the date at which this fourth obelisk came to the ground, nor how the downfall happened. Mehemet Ali, Pacha of Egypt, presented the prostrate obelisk to George the Fourth in 1820; and there it still remains in 1875. To accept a present is one thing; to bring it home is another, often much more difficult. The obelisk still standing at Alexandria obtained in old days the name of Cleopatra's Needle; but the English have been accustomed to give this designation to the prostrate monolith now belonging to us; and so we will speak of it in this article.

The question is: can Cleopatra's Needle be transported to England? The weight is estimated at 200 tons; and there is no pulling to pieces a monolith to facilitate removal. From time to time, statesmen and travellers have expressed an earnest desire that we should not quite neglect Mehemet Ali's gift; the late Sir Robert Peel thought that it might fittingly be set up somewhere in England, as a memorial to Sir Ralph Abercrombie and the other British officers who fought and fell in Egypt. How the obelisks were conveyed to Alexandria is not now known; there is no quarry of porphyry within six hundred miles of the spot; in all probability, the large masses were in some way floated down the Nile.

The obelisks transported from Egypt to Rome are not the largest of the class; but one now at Paris is interesting in an engineering point of view. At the entrance to the great Temple of Luxor, at Thebes, were two obelisks, larger and finer than those at Alexandria. When Napoleon was in Egypt, at the commencement of the century, he was struck with the grandeur of these monoliths, and conceived the idea of sending one or both of them to France. The fortune of war was against him; and the scheme was forgotten. Thirty years later, towards the close of the reign of Charles X., application was made to Mehemet Ali for a gift of one of these obelisks. The request was acceded to, and preparations were gradually made for utilizing the gift.

Let us see how the transport of such ponderous masses has been managed in a few instances; it will enable us the better to understand the suggested modes of bringing Cleopatra's Needle to England.

No record exists, as we have stated, of the means by which the porphyry obelisks, or the blocks to make them, were transported from the quarries to Heliopolis; but Herodotus mentions the transport of a large block of granite from Syene to the delta of the Nile, to form a monolith temple. The block measured 32 ft. long, 21 ft. wide, and 12 ft. high; its estimated weight was at least 300 tons. The transport of this huge mass down the Nile occupied, we are told, two thousand men for three years—partly by dragging overland, partly by flotation down the river. A little more detail is given by Pliny of the transport of an obelisk, 120 ft. high, from the spot where it lay to the Nile. In the first place a canal was dug along the line of route. Two boats, filled with pieces of stone having the aggregate weight of the obelisk, were placed side by side on the canal; the stones being in foot cubes, the ratio of weights could be adjusted with facility. The two ends of the monolith rested on the two banks of the canal; and the two boats were laden sufficiently to pass beneath it. The cubes of stone being then taken out one by one, the boats gradually rose, until at last they touched and bore up the obelisk; they were then towed down the canal to the Nile, bearing their burthen with them.

Concerning the numerous Egyptian obelisks at Rome—about a dozen in number, and varying from 186 ft. to 40 ft. in height—we have an account of the transport of the largest and heaviest of all, now known as the Lateran obelisk—the transport, that is, down the Nile and along the Mediterranean. The conveyance from Heliopolis to Alexandria was probably effected by means of a canal, in some such way as that described by Pliny. A ship, manned by three hundred rowers, was built to convey the obelisk to Europe. When it had made its tedious and laborious journey across the Mediterranean, the obelisk was dragged ashore on one bank of the Tiber, and moved on rollers through the Gate of Ostia to the Circus Maximus. Then, to raise it into a vertical position, large beams of timber were firmly imbedded upright in the ground; strong ropes were passed from beam to beam; and by the aid of these ropes and pulleys the small end of the obelisk was gradually raised until the proper vertical position had been attained.

During the course of many centuries successive popes procured the transport of other Egyptian obelisks to Rome. The work, in most of the instances, comprised five successive labours—(1.) To drag the obelisk from its site to the banks of the Nile; (2) to float it down that river; (3) to convey it across the Mediterranean; (4) to ascend the Tiber; (5) and lastly, to erect it in its destined spot at Rome. In the instance of that which is now known as the Vatican obelisk, no less than five hundred different plans were sent in; Fontana's was accepted; and he gained no small renown by successfully achieving the work.

Now we come to the operations of the French in bringing to Paris the Luxor obelisk, presented by Mehemet Ali to Charles X. M. Lebas was intrusted in 1831 with the engineering responsibility of the undertaking. He first built a vessel of fir, substantial enough to make the voyage on the Mediterannean and the Atlantic, but narrow and shallow enough to navigate the Nile and the Seine. While this was slowly working its way up the Nile from Alexandria to Thebes, other operations were being conducted on shore. Eight hundred men were employed for three months in making an inclined plane from the Temple of Luxor to the river's bank, a distance of about four hundred yards. The obelisk was lowered, and incased in timber, to avert fracture of the stone and abrasion of the sculptured surface. The immense mass of two hundred and fifty tons was dragged to the river and on board the ship by formidable appliances of manual labour and mechanical contrivances. All this consumed much time. The ship or vessel had started from the port of Toulon, and occupied four months in reaching Thebes; the crew of a hundred and forty men worked hard, and suffered much from heat, sand-storms, and ophthalmia during the slow navigation up the Nile. At Thebes the staff and men made a regular encampment of barracks, sheds, tents, bread-ovens, provision stores, &c. The bow end of the vessel was temporarily cut off to admit the obelisk end on. This work was finished as winter approached; but the waters of the Nile were then too low for the flotation of the ponderous cargo; and, apparently, through some miscalculation, or possibly an exceptionally dry season, the voyage down the river could not be begun till after a tedious delay of eight or nine months. Three long months were consumed in the voyage down the Nile, and six more in reaching Toulon—so multiplied were the difficulties in battling against shoals, tides, currents, and winds, in days when there was no steam marine to help them. A monolith, 70 ft. long and weighing 200 tons, could not be coerced; it had to be coaxed and humoured. Fifteen more months elapsed, and then the navigators were only at Cherbourg, having had to contend with obstacles of many kinds in rounding Gibraltar, getting up the Atlantic, and crossing the stormy Bay of Biscay. The slow-going burthen was towed along from Cherbourg to Hâvre, and up the Seine to Rouen and Paris. Meanwhile, extensive preparations had been making at Paris. Blocks of granite of immense size were brought from Brittany to form a pedestal or base. An inclined plane was formed from the banks of the Seine to the Place de la Concorde, where a platform of rough masonry was formed on a level with the top of the pedestal. The obelisk, on a timber carriage, was dragged up the inclined plane by ropes and capstans. When at the proper spot, and the lower end properly controlled as a fulcrum, the upper end or apex of the obelisk was gradually raised by the aid of ropes and pulleys fixed to ten lofty masts. It was not till October, 1836, that M. Lebas saw his anxious work finished, after a series of operations that had occupied his attention for nearly six years, and the expenditure of a very large sum of money by the Government.

It will thus be seen that Egyptian obelisks of vast size *can* be brought to Europe, and set up in proper vertical position. English engineers could do the like if proper scope were given to them; and the question that still waits for a solution is—Shall we do this in regard to Cleopatra's Needle?

It appears that, after the French army was expelled from Egypt in 1801, Major-General Lord Cavan claimed possession of the "Needle" as a trophy of war, without asking permission either of Pacha or of Sultan; and a subscription was com-

menced among the officers to defray the cost of bringing it to England. A temporary timber jetty was constructed from the prostrate obelisk to the nearest bank of the Nile; but, subscriptions failing, the enterprise was abandoned, and the whole affair forgotten, except by a few travellers in the East. Mehemet Ali, as we have said, formally presented the obelisk to us in 1820; we thanked him, but did nothing further in the matter for a long series of years.

In 1847, Major-General Delamotte, who was then in Egypt, reported that Cleopatra's Needle was still in the same state as before, save a little chipping at some of the edges. In the next following year the late Prince Consort wrote a letter, expressing his willingness to join in a subscription for bringing the obelisk to England. In 1849, Mr. John Macgregor (now known as the Rob Roy canoe voyager) visited Egypt, and found the prostrate monolith two-thirds buried in the sand, which was accumulating on it more and more every year. In 1851, two British officers acquainted with Egypt memorialised Lord John Russell, asking for aid from the Government in the matter, but without success.

A very detailed plan was drawn up in 1852 by Mr. Elmes, the architect. The Crystal Palace Company had been formed to purchase the Hyde Park Exhibition building, transport the materials to Sydenham, and there construct a magnificent palace, garden, and park. The directors considering that Cleopatra's Needle would prove a great attraction, the late Earl of Derby, who had succeeded Lord John Russell as Prime Minister, offered to *lend* it, provided the Company would pay the cost of transport, and would undertake to give it back to the State if demanded. Mr. Elmes sent in a plan and estimate; but the directors, either hesitating at the cost or changing their opinion as to the interest the public would take in the matter, abandoned the project. Mr. Elmes afterwards published his plan *in extenso*, and as his details are very minute, likely to be suggestive to other persons, we will notice it somewhat fully, premising that he had already been engaged in discussing a scheme for removing to a spot on the Thames, and setting up near Windsor, a magnificent block of Cornwall granite, which, if wrought, would have made an obelisk 102 ft. high by 9 ft. square at the base. This scheme came to nothing; but the planning and calculations connected with it were of service, while considering the proposition for bringing Cleopatra's Needle from Alexandria to Sydenham.

Mr. Elmes proposed to dig a dry dock near the prostrate obelisk, larger in all its dimensions than the obelisk itself, with sloping sides and ends. Timber constructions of great strength would then be provided; first, nine equidistant baulks of timber transversely across the bottom of the dry dock; then a massive timber along the centre of the dock, in a longitudinal direction, to form a kind of keel; next, an uninterrupted platform of timbers, longer than the keel, and seven or eight feet wide, all the timbers bolted firmly and strongly together. Then would begin another series of masses of wood, an upper platform of timbers ranged longitudinally instead of vertically, the platform longer and wider than the one beneath it, and tapering off to a point at each end; a third platform of transverse timbers, and longer than either of those below; and so on to a fourth platform, and then a fifth, each projecting further than those underneath it. The timbers being close together, these five platforms would constitute a solid mass, 80 ft. long, 24 ft. wide, 6 ft. deep along the centre, and 3 ft. deep at the sides. Such a mass, if firmly held together, would possess great buoyancy in sea-water. All this would be mere carpentry, easy to manage with the necessary timber and labour at hand. Then would come the task of placing the obelisk on the raft (if we may give this name to the mass of timber). The surface of the raft would be about 4 ft. below the level of the ground on which the obelisk lies. A smooth inclined plane would be made down to the raft; and the upper surface of the raft itself would be thickly padded with cotton. Capstans and flat ropes would draw the huge monolith down upon the raft, where it would be completely built in with timbers at top and sides, prevented from abrading the surfaces by layers of cotton. A sheathing of 3-in. deals would finally cover all the bolted timbers. Then for the navigation. Two hundred tons of stone, enveloped in 600 tons of timber would, Mr. Elmes calculated, be quite safe on the sea, as 400 more tons would be required to sink it. The raft-ship, with its inclosed treasure, would be provided with bulwarks, rudder, steering-wheel, bowsprit, masts, yards, braces, spars, blocks, sails, cabins, store-rooms, tanks of water, lockers of provisions, &c.; and the outer surface of the mass would be caulked and painted for preservation. A canal would be dug from the dry dock to the Nile; the dock and canal would fill with water; the raft would float, and would be navigated to England as a slow sailing ship. Arrived in the Thames, the raft would be floated into the Collier Dock at Deptford. The timbers would be removed one by one and the obelisk transferred by powerful tackle to six railway trucks. Two goods locomotives would draw it along the railway which has been laid down from the Collier Dock to the grounds of the Crystal Palace, where other tackle would lift it into its destined place.

Such was Mr. Elmes's ingenious plan. It might be asked, and was asked, why not put the obelisk into, or lash it alongside of, a regular ship? He replied that no ordinary ship is fitted to receive such a mass, without extensive and expensive alterations; and that if the obelisk were lashed to one side of a ship, it would require a counterbalance at the other side very difficult to manage in a stormy sea. Mr. Elmes estimated the total expense of his scheme at about £5,000, of which £2,000 would be returned for the timber and fittings of his singular vessel.

Some authorities state that the walls of modern Alexandria are actually built over part of the prostrate obelisk; and that, in 1853, the (then) Pacha of Egypt urged this as an objection to disturbing the obelisk at all.

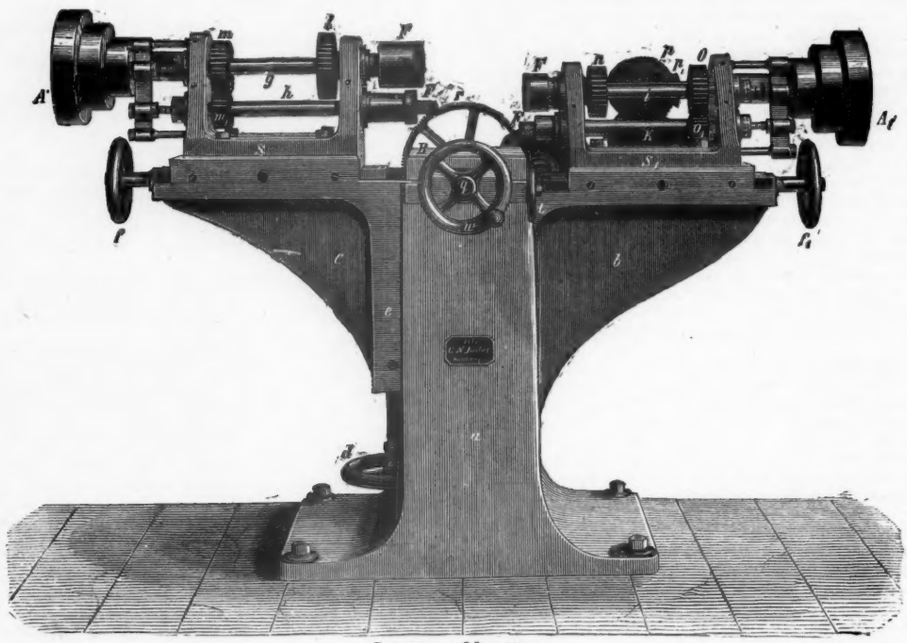
In 1862, when the International Exhibition gave us a renewed interest in foreign countries, a project was started for bringing over Cleopatra's Needle, and setting it up in Hyde Park, to mark the spot where the first Exhibition building had stood; but, as no movement was made towards obtaining the necessary funds, the project came to nothing. In 1867 an English traveller, on visiting Egypt, examined the prostrate monolith somewhat minutely, and found many of the hieroglyphic inscriptions almost obliterated. It appeared to him that the salt of the sea, aided by sand winds, had brought about this result, and that the obliteration will increase more and more the longer the mass remains in its present position. The Arab donkey-drivers have, in addition, chipped off the exposed angles to a serious extent, to sell the fragments to tourists—those tourists who are playing such havoc with ancient monuments by the silly vanity of bringing home relics. When the Prince and Princess of Wales visited Egypt in the winter of 1868-9, Dr. W. H. Russell, who accompanied them, made similar observations, and dwelt on the fact that the removal ought no longer to be delayed; he all the more urged this, because the Egyptian Government are half disposed to deny the right of England to that which we have so long neglected to avail ourselves of.

After many intervening projects, a renewal of the discussions has taken place during the present year (1875). Mr. Haddon, C.E., has sketched a plan for transporting the Needle from Alexandria to the Thames Embankment. Build round the prostrate obelisk on all sides with timbers, until the whole mass is converted into a solid cylinder of stone and wood; roll this cylinder down to the sea-shore on wooden rollers, and launch it into the water; employ a steamer of sufficient power to tow it from the Nile to the Thames, where the monolith, stripped of its timber garment, would, by mechanical agency, be lifted upon the Victoria Embankment, and finally set upright on the spot selected. In order to enable the mass to float, Mr. Haddon calculates that the diameter of the cylinder must be 20 ft.; this would require a vast mass of timber around the obelisk, especially near its smaller end. He considers that the operation would be much easier, less exposed to risk, more expeditious, and less expensive than was the removal of the Luxor obelisk to Paris.

Major General Sir J. E. Alexander has made a suggestion to the Metropolitan Board of Works that this undertaking should be carried out at the cost of the ratepayers, as a means of imparting a new grandeur to our Embankment, which is in so many other ways a credit to the Metropolis. He said it would be a reflection on our engineering skill to talk of "insuperable difficulty;" and, as to cost, he saw no reason why it should not be kept within £3,000. He denies that the obelisk has been much injured, except that the donkey-drivers have chipped off portions of the exposed edges; most part of the surface is buried in the sand, and this has preserved the hieroglyphics from injury. The effacement spoken of by one or two other travellers refers to the exposed portions, which are but small in extent.

Mr. J. Dixon has suggested a plan for building around the obelisk with boiler iron, strengthened with diaphragms: forming, in fact, a large boiler 14½ ft. diameter, with the obelisk securely fixed along the central axis. This, made water-tight, would float; if rolled down to the Nile, it might then be towed along, especially if provided with bilge-keels, ballast, spar deck, rudder, &c.

No question exists that the work is within the competency of English engineers, and it will be a pity if the matter is allowed again to go to sleep.



SLOTTING MACHINE.

SLOTTING MACHINE FOR SEWING-MACHINE MANUFACTURERS.

FOR some time past the firm of Justus & Co., of Hamburg, has produced a variety of machine-tools specially designed for the use of sewing-machine makers. The chief advantages presented by these tools is, that not only do they allow the work to be turned out faster than by hand, but they facilitate the interchangeableness of the parts by insuring exactitude and uniformity of detail.

The adjoining fig. from the "Moniteur Industrielle Belge" shows one of Justus' machines for slotting the tables of sewing-machines.

It is formed of a hollow cast-iron support *a*, with two arms, *b* and *c*, of which one, *b*, is cast in a piece with the support, whilst the other, *c*, is detached, and has a vertical slide movement controlled by the hand-wheel, *d*, and a clamp-screw, *e*.

In guides on the upper surfaces of the arms run the sliders S and S, the transverse movements of which are adjusted by the hand-wheels *f* and *f*. The sliders carry the spindles *g*, *h*, *i*, *k*, driven by the pulleys A and A, by means of the cog-wheels *l*, *m*, *n*, *o*. The extremities of the spindles carry the cutters, F, F.

The plate to be fashioned is securely clamped, in a vertical position, by a special arrangement worked with a single screw, to the table B, which can be adjusted in a direction perpendicular to the cutters by the hand-wheel *n* working on the axle *g*. An automatic movement in the same direction can be imparted to the table and the plate it carries, through the train, *p*, *p*, *i*, *r*, *r*. The latter can be thrown out of gear instantly, if required, by the tappet *t*.

MAKAROFF'S MATS.

OUR attention has been recently drawn to an invention that promises to be of great service to shipping interests. No doubt the majority of our readers have read or heard of leaky ships being brought safely to port by the expedient of drawing a sail beneath the ship's bottom at the leaky point; the process is called by sailors "Fothering" the leak, and is executed as follows. Two new and strong sails are obtained, and, a quantity of oakum or other loose tough stuff being placed between them "sandwich" fashion, the whole is well quilted together, or, as the sailors say, "thrummed;" ropes being then secured to the corners, the sail is lowered over the bows, and the ropes being pulled along at either side of the ship the sail is conducted to the leak, against which the suction and pressure of the water quickly forces it, and the sail having been well tarred is nearly water-tight, and the leak is staunched fairly well.

This expedient suits wooden ships very well, but is not adapted for iron ones, because the jagged edges of a torn plate quickly cut through the sail. Some years ago Lieutenant Makaroff, a young officer in the Russian navy, thought of developing this device, and the "Makaroff" mat is the result of his labours. This mat consists of a ¾ rope of the finest hemp closely woven into a mat; it is then dressed with waterproofing composition. The face of the mat, which is to rest against the ship's plates, is soft and spongy, somewhat like the face of a common door mat, it has of course suitable eyelets for the ropes guiding and securing it, and its success with iron ships is due to the sponginess of its inner face, which thus insinuates itself into every crack and inequality, and consequently, as there is no special pressure on any one point, no cutting action can ensue, while, owing to this dovetailing of the mat into the leak, there is the less risk of its being displaced by the motion of the ship or the current of the water. We understand that practical trials of these mats have proved that they are excellent devices for their special purpose. Messrs. Cresswell and Co. of Leadenhall Street are introducing them into this country.

NEW PORTABLE GAS FURNACE.[1]

MR. T. FLETCHER, F.C.S., of Warrington, who is so well known for his laboratory furnaces, has just brought out a new gas-furnace for general purposes and for the treatment of refractory substances at high temperatures, which is highly spoken of by chemists and manufacturers, and appears to supply a long-known want.

This furnace opens a new field of experimental research, the temperatures attained by its means with ease and precision

[1] "Journal of Applied Science."

having been up to the present time obtained only with considerable difficulty. It will burn perfectly in the same space any available gas supply from 10 ft. to 60 ft. per hour, or more if required, giving temperatures in exact proportion; and any operation may be repeated at any time by taking a note of the position of the air slide which governs the combustion of the gas.

A small furnace, with half-inch gas supply pipe, day pressure, starting with the furnace cold, will melt silver in three minutes, cast iron in eight minutes, cast steel in 25 minutes. With a supply of 50 ft. per hour the same results are obtained in a little over half the time, and so on in proportion with a greater or less gas supply. It will work satisfactorily for gold, &c., melting with a supply of gas too small for any previous known furnace, and the maximum temperatures obtained are limited only by the available gas supply and the fusibility of the fireclay casing.

The furnace can be used for the dirtiest and roughest operations without damage, and the fracture of a crucible or boiling over of its contents entails no loss or injury.

A trade journal, "The Jeweller and Metal Worker," speaking of it, calls it "a perfect jeweller's furnace," and adds :—

"There need be no fear of want of power, as this furnace, with the gas supply given above, is in use for iron assays and steel-melting; what is required for the jeweller's workshop is, therefore, a drop in the ocean when compared with its available power. When the slide which controls the combustion of the gas is closed entirely, a supply of about 10 ft. per hour only is required; when fully open, about 45 feet, and the speed of working is in exact proportion. The faults which condemned gas-furnaces for jewellers' use are here overcome completely, and when the superior working qualities of gold, &c., melted in a gas-furnace, are taken into consideration, there can hardly be a doubt as to its successful introduction in the trade generally."

PENETRATION OF ROOTS IN ROCK.

IN the Paris Exposition of 1867, some specimens of white marble were exhibited, in which were furrows channelled in the stone by the action of the carbonic acid exhaled by the growing roots of adjacent trees. M. S. Meunier reports a similar case at Orsay (Seine et Oise) in a still more resisting material, close-grained silicious sandstone. Here the roots of some elm trees were found to have made their way into the rock by decomposing the very small portion of calcareous matter cementing together the silicious particles. An entrance thus effected, they seem to have acted, in part chemically by dissolving the cement, in part mechanically by forcing the grains of sandstone apart. In this respect the fibrils appear to have been much more active than the larger roots. Eventually, they died off for lack of nourishment, and the greater part of their remains disappeared, leaving only tubular moulds, varying in length from 1 millim. to 1 centim. ($\frac{3}{100}$ to $\frac{3}{10}$ in.), with sides bearing the exact imprint of the roots. These were rendered more conspicuous by the yellowish stains due to the subsequent infiltration of surface water impregnated with iron. The case affords a good example of the manner in which roots occasionally penetrate into masonry, and is not without significance in a geological point of view, as showing that traces of recent vegetation may occur in rocks of older date.—*Comptes Rendus*, lxxx. 11*th Oct.* 1875.

MENIER'S CHOCOLATE FACTORY AT NOISIEL.

THIS magnificent establishment, which now covers over a hectare (2¼ English acres) of ground, stands in a smiling valley on the banks of the Marne, about a couple of miles from the railway station at Chelles. It had its origin in a humble mill of the days of Louis XV., a dependency of the ancient abbey of Gournay. After having been several times rebuilt and enlarged, it was transformed in 1825 by M. Menier Père into a manufactory of pharmaceutical preparations, particularly of chocolate. Statistics prove that the total quantity of this commodity then manufactured in France scarcely amounted to 300,000 kilogs. In a previous notice of the sugar-refineries at Nantes, we instanced some curious examples of what we may be permitted to term "cellular juxtaposition" in industry; where the modest germ of some enterprise developed by an ancestor has become enlarged to proportions such as the wildest imagination could never have ventured to anticipate. So it was that Brittany consumed just sugar enough to keep a refinery going with *five* hands, and the fourteen similar establishments which Nantes reckoned turned out together in the course of a year about a million pounds of sugar—a quantity which the great refinery now building at St. Ouen or that of M. Say would manufacture in *ten days*.

The growth of the factory at Noisiel is a no less striking example of the effects of concentration and subdivision of labour; and the half-million *tablettes* of chocolate it turns out every day afford a fair notion of the industrial resources of the establishment.

The smallest details are carefully elaborated. Every operation is performed mechanically, from the cleansing of the *cacao* to the folding and packing of the manufactured article. Covering the cakes of chocolate gives employment to 120 women; and the tinfoil with which they are covered represents alone an annual outlay of 250,000 francs. Situated on the bank of the Marne, the establishment derives its motive power from several large turbines, to which have lately been added a couple of fine steam-engines of 60 horse-power each. The establishment is built in five stories, and each compartment is provided with the machinery requisite to some process in the manufacture. The picking and cleansing, drying, grinding, weighing, and pressing into moulds are all executed by machines of the most perfect description, and admirably kept. We particularly noticed two *salles de transmission*—one underground, the other on the first floor of a building over the water. The cooling-rooms are immense cellars fitted with tables of marble and cast iron, beneath which a current of cold water and air is made to pass, so as to maintain continuously the requisite lowness of temperature. M. Menier, who is also a large sugar-refiner, has not rested content with being one of the foremost manufacturers of the age, he has also exhibited a truly philanthropic spirit in the erection of stores, baths, reading-rooms, refectories, and in establishing classes for adults at Noisiel. On his own property he is now building a large town for his workpeople, which will put the finishing touch to the masterly organization with which he has endowed an establishment where principals, clerks, and operatives, united by sentiments of fellowship and mutual dependence, appear rather like the members of a single family. The example he has set is too laudable to be passed over without giving the meed of praise it deserves. *Les Mondes, from the Journal des Fabricants de Sucre.*

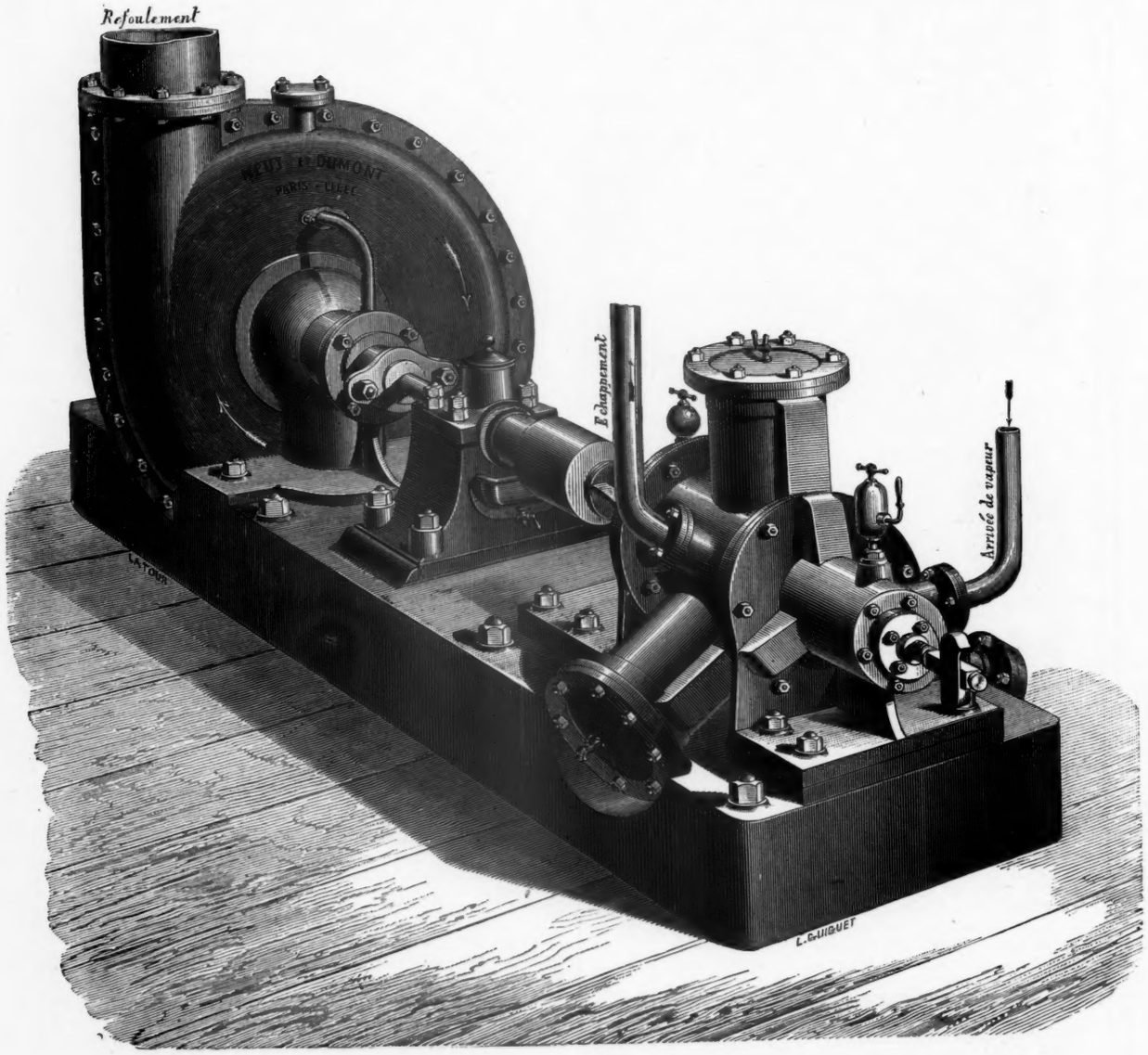
CENTRIFUGAL PUMP.

By Neut & Dumont.

THE illustration on the following page represents a centrifugal pump, by Neut and Dumont, combined with a three-cylinder engine. In many cases, as on shipboard, it is difficult to drive a pump with belting; space is not available for the purpose, and the high temperature of the engine-room is detrimental to the running gear. Transmission by wheel work is heavy, and adapted only for low rates of speed. It is therefore necessary that centrifugal pumps should be driven direct. Ordinary engines with one or more cylinders accommodate themselves with difficulty to the high speed necessary, and suffer proportionately. The three-cylinder engine, not being open to these objections, has been adapted by MM. Neut and Dumont in the manner shown in the figure. The arrangement was first tried on board a merchant steamer, the "Franchetti," and with complete success. The water was thrown to a height of 7 metres, the pump making 450 revolutions per minute easily. Since then, powerful pumps of the same description have been ordered for several French ironclads. The "Colbert," just launched at Brest, has one of these pumps, which will make 530 revolutions per minute, and throws 800 tons of water per hour.

There are other purposes connected with marine engines for which the centrifugal pump is admirably suited, as in the distribution of water in surface-condensers. Here, as the action required is slower and uniform, ordinary engines are employed. A very powerful pump of this description is now constructing, by the inventors, for the ironclad "Richelieu."

The second illustration (see frontispiece to this volume) shows the application of the pump to purposes of irrigation—a subjec, that has acquired additional importance at the present momentt as inundation of the vineyards appears the only really certain preventive of the ravages of the phylloxera. *Revue Industrielle.*



CENTRIFUGAL PUMP. By Neut and Dumont.

STEEL IN ENGINEERING PRACTICE.

WE quote the following paper from the "Journal of the Franklin Institute," Pennsylvania :—During the session of the American Railway Master Mechanic Association, in New York, last May, some experiments were tried to show the comparative strength of cast-steel and wrought-iron car axles. The experiments appear to have been conducted under the supervision of a committee appointed by the Association, the steel axles having been furnished by the Midvale Steel Works of this city, and the iron axles selected by two members of the Association who desired the test; one lot of iron axles having been forged expressly for the test at the shops of the gentleman furnishing them, the other lot having been selected by the other gentleman from the axles used successfully on the road under his charge. A full account of these experiments appeared in the June number of the "American Artisan" of New York, one of the editors of that paper having been present during the test, and an abstract of the report of the committee was published in the "Railroad Gazette" of New York. These accounts have been pretty generally copied into other journals, and the experiments have been mostly received as useful, and corroborative of the commonly conceived idea of the superior strength of steel. These experiments consisted in letting fall a drop weight of 1600 lbs. from heights of 25 and 35 ft. upon the bars of iron and steel which rested on rigid supports placed 3 ft. apart, the blow being delivered midway between the supports. While some iron axles stood three or broke at the fourth blow, others broke at the second blow, all of 25 ft. fall; and the only steel axle that was broken at all had three blows of 25 ft. and then eight blows from the height of 35 ft.

It may be well to state that the experiments tried in New York were merely a repetition or an exposition of the test adopted by railroads using steel rails in determining the fitness of the steel for railroad purposes. On the reasonable assumption that car axles are submitted to strains requiring stiffness and strength, the test of dropping a weight upon the axle and noting the deflection seems one that would naturally be resorted to. It has, therefore, come to be common practice, in ordering steel axles, that for one hundred axles ordered a certain number agreed upon in addition shall be furnished—that this additional number, selected at random from the pile, shall be subjected to the following test: they are placed one at a time upon rigid supports, 3 ft. apart; upon the centre of the axle, midway between the supports, a drop weight of 1500 lbs., raised 25 ft., is allowed to fall that distance. The amount of bending caused by the blow is noted. The axle is turned over and another blow from the same height is given, which straightens the axle more or less; so turning the axle between each blow, five blows are given. If all the test axles stand these blows, the whole lot is accepted; if any of them break, they are all rejected. It is usual to continue the test by blows of 1500 lbs., drop falling 40 ft., until the axles are broken; but all blows after the first five are not considered in the test, so far as the acceptance of the axle is concerned. The trial of the sample axles is supposed to show two things: great strength to resist strains or shocks, and, in relation to the amount of bending, the hardness or stiffness of the material. We have seen steel axles break on the second blow, and we have seen them so tough as to require many 40 ft. blows to break them. We cannot but think the test the best one possible under the circumstances.

It has been our intention to comment on these experiments, but we delayed doing so to obtain some definite information from prominent railroads as to the success of the steel axles in actual use. While engaged in this inquiry, we are met by an article in one of our exchanges, a widely circulated paper devoted to the iron interest. The article is headed "Steel Railway Axles." After commenting on the nature of the test, the writer says: "If tests made by means of weights subjected an axle to strains in any respect similar to those it encounters in actual service, the results might be considered as conclusive; but they do not; consequently, they are practically valueless as determining whether steel is, or is not, a better material than iron for this use." Again: "It (steel) has from time to time been tried on railroads, and each time abandoned." Then the writer gives his conceptions of the reasons for this, and further on says: "Steel axles have been placed under cars on several different railroads by gentlemen with whom we are acquainted, and in each case they were abandoned on account of their liability to heat. We know this as a fact, although we do not know the reason for it." These few sentences suggest a treatment of the subject not originally intended. That steel car axles should have been tried and then abandoned is not surprising, as the cost of steel is even now very much greater than the cost of iron. But that their use should have been abandoned on account of steel being more liable to heat is a matter of great surprise, and worthy of careful consideration. An inquiry of the leading engineers other than railroad engineers fails to elicit any experience that would seem to confirm this statement. All that we have heard about steel being liable to heat comes to us in statements somewhat like the article above referred to—that is to say, a mere assertion without any explanations of the conditions under which the trial had been made.

We are told by the writer before alluded to that a certain size of journal is needed for purposes of lubrication, and that the master car-builders' standard axle has journals $3\frac{1}{4}$ in. diameter, while $3\frac{1}{8}$ in. journals are carrying the load with probably a large margin of strength, but with too little surface for lubrication. Friction being independent of surface within certain limits, the $3\frac{1}{8}$ in. journal in iron, if 5 in. long may heat, if 6 or 7 in. long may, with its lateral increase of surface, bear the load with safety from heating, and no more frictional resistance, because the diameter, and consequently the surface velocity, has not been increased. Does it not seem reasonable that, with some stronger and stiffer material than iron, the journal may be made to present to its brass box the amount of surface needed to prevent abrasion in a less diameter and a greater length?

There really seems no reason why the practice of the railroads should differ materially from the practice of the workshop. Car axles revolve under conditions not much worse than the journals and shafts in many machines, and what applies to one applies as much to the other. Any journal, if submitted to too much pressure, will heat. When it does heat from causes other than want of proper lubrication, it is necessary to diminish the load, to diminish velocity, or to extend the surface under pressure, and, in the case of journal, all the things being equal, this extension can best be made useful by extension in length, not in diameter. In an over-hanging journal, as the outside bearing of car axles, an enlargement of diameter increases velocity of the rubbing surfaces, and so increases the frictional resistance, inasmuch as the same frictional resistance is acting at a greater distance from the centre. An increase of length, the diameter remaining the same, will diminish the wear without increasing the frictional resistance, inasmuch as the pressure per square inch of surface will be less. When the limit of extension has been reached in such journals on iron shafts of a given strength, no engineer would hesitate to make them still longer if a stronger and stiffer material can be substituted for the iron.

At the same session of the Master Mechanics' Convention at which the steel axles were tested, the form of iron recommended by the master car-builders, with a journal $3\frac{1}{4}$ in. diameter, 7 in. long, was not adopted, on account of its being larger and heavier than axles doing good service, and on the minds of some who voted, on account of the probable introduction of *steel* axles of a much smaller size than could with safety be made of iron. While some roads, as we are told, have tried and abandoned steel car axles, we know that others have used them, and are using them successfully after a continuous experience of many years.

We have made inquiry of one railroad using steel axles extensively, and found that it alone has nearly 26,000 steel axles in use under its passenger and some freight cars.

It may be asked why roads so using them do not take advantage of the extra strength and stiffness, and reduce the size of the axles, to diminish the dead weight, to diminish the cost, and to diminish the frictional resistance?

We hope soon to be able to present to the readers of this Journal a statement of the experience of this railroad now using 26,000 axles, when it will be seen that that road does use as long a journal, and one of smaller size, than that recommended by the Master Car-Builders' Association, and use it to advantage—made of steel.

That other railroads using steel axles should not at once avail themselves of this advantage of steel is clear enough to those familiar with the management of roads. Changes in such matters as size of axles involve great changes in many other portions of the cars. Such changes cannot be made at once; a wise policy retains existing sizes, but insures security to passengers by the one of the stronger material in the equipment of passenger cars, and then slowly and surely makes any changes that may seem warranted by experience, not of one year, or two years, but of many years, and as indicated by the clear record of all that experience.

Inasmuch as the steel interests of this country are now so rapidly increasing, we deem an inquiry into its possible displacement of iron in engineering practice of great importance.

We have been informed that steel is entering more and more largely into the construction of locomotives abroad, and, if, we

mistake not, the engines made for a Russian railway last year by the Grant Locomotive Works, of Patterson, N. J., had all parts that could be made of steel. The rapid advance of the steel manufacture in this country, and the cheapening of the material by improved methods of manufacture demand a careful consideration of its merits in machine-construction.

Steel is now procurable of different qualities, suited to different uses to which it may be applied, and we think the time is near at hand when these qualities will be so well defined as to render their selection by the engineer an easy matter. All the so-called steels, from the finest tool steel down to the qualities which contain so little carbon as to prevent them from showing any hardening properties when heated and cooled suddenly, seem to have physical properties which readily distinguish them from what we know as bar or wrought iron. The process of manufacture of the low grades of steel is so distinct from the mode of making the wrought iron of commerce, that the so-called steel, containing the least possible amount of carbon, differs materially from the so-called wrought iron, which has been proved to contain the greatest amount of carbon. This difference is marked in regard to strength and stiffness. Steel of all grades, from the softest up to the hardest, behaves differently in the lathe from wrought iron, presenting a more uniform surface when turned or planed, and seldom showing any sign of seam or fibre, as is evidenced in wrought iron.

This finer surface, the greater strength, the greater stiffness seem to indicate it as *par excellence* the material for machine-construction. On railroads steel rails are taking the place of iron, steel tires are encircling the driving wheels, steel sheets form the boilers, and steel connecting rods of light model are in some cases taking the place of the more cumbersome iron ones; but yet we are told that steel car axles are more liable to heat than iron ones.

We have heard the same statement made of steel crank-pins; we have, therefore, included them in our inquiries of railroads using them, and we look for the report now being prepared for us with interest. In machine-shop practice we found examples of steel crank shafts succeeding where iron shafts failed.

As an illustration of this displacement of iron by steel in engineering practice, mention may be made of the experience of a firm in this city. Some small engines were being constructed, intended to be run at high speed, 900 revolutions per minute. They were fitted with wrought-iron crank shafts, carefully fitted to run in phosphor-bronze bearings. In the first trial of one of these engines, the shaft cut so badly as to stop the engine long before the proper speed had been obtained. The shaft was taken out, smoothed up, and the bearing carefully lapped out, to give more room for oil, and, under an unusual lubrication, it again cut. A case-hardened iron shaft was tried with slightly different result. Steel was then used, and the same size steel shaft ran without cutting, and showed, after long use, no unusual wear. The steel used was that known as machinery steel, and was adopted in place of iron only on account of its being stiffer. A careful examination of the conditions under which the soft iron and the case-hardened iron gave out clearly indicated that the shaft bent in the journal under the pressure of the work on the crank.

In machine-shop practice, iron shafts are used on account of their cheapness wherever practicable; but when it is deemed advisable not to increase the diameter, on account of the velocity or for other reasons, steel is always resorted to as permitting greater strains, so that, in considering the proportions of machines, it is common usage, in case of doubt as to strength of shafts, to substitute steel for iron.

Engineering, Building, &c.

ABSTRACTS FROM FOREIGN PERIODICALS,
TRANSACTIONS OF SOCIETIES, ETC.

§ 1. *Engineering.*

CLEANING the Outside Under Surface of Boilers.—PIEDBŒUF, of Aix-la-Chapelle, provides for this by carrying a steam-pipe along the outer surface of the boiler, where it is in contact with the products of combustion. The pipe has stop-cocks at equal distances along, by which jets of steam can be turned on, from time to time, in the direction of the draught. The surface is thus kept clean, and conducts the heat better, thereby economizing fuel considerably. *Moniteur Indust. Belge*, 10*th Oct.* 1875.

Drying Moulds for Iron Castings.—In most foundries moulds are dried by means of iron plates, over which a bright coke fire is kept burning. This method entails a great waste of caloric, as the heat acts by radiation, and in most instances there is a free circulation of air about the place.

For large articles, as fly-wheels, cylinders, &c., the high temperature required is also a source of great inconvenience to the workmen. It seems strange that some less clumsy method should not have been adopted before. M. DELHOMME has invented a simple plan for obviating these disadvantages in question. The mould is laid in a horizontal position, in a sort of trench in front of a coke furnace, the heated gases from which are introduced to the interior of the mould by a pipe; the draught is regulated by a small chimney provided for the purpose. It is hardly necessary to point out the advantages of this arrangement. The drying is effected much more equably; the waste of heat is enormously reduced; whilst the gaseous products of the furnaces being carried off by the chimney, in place of being allowed to disseminate themselves through the foundry, greatly contribute to the salubrity of the latter. But the chief consideration with most founders is cheapness. Now, the new arrangement has been proved to effect a saving of 50 per cent. During the six months that it has been in use at the works of Quillacq and Co., the saving in coke alone has amounted to between 600 and 700 francs a month, not to speak of the large quantities of wood which were formerly required for getting up the fires, for which purpose a few shavings are now found sufficient. *Moniteur Indust. Belge*, 10*th Oct.* 1875.

Giffard's Cold-Air Engine.—The "Moniteur Industriel" describes this invention as one of the marvels of the Palais d'Industrie, and the most perfect solution yet achieved of the great problem of the industrial application of cold, which has been the subject of so much fruitless research for more than thirty years past. The principle on which it is based is this: When air is subjected to compression, a certain degree of heat is developed. When deprived of the heat so developed, and subsequently allowed to expand against the piston of an air-tight cylinder, it re-absorbs heat so eagerly as to produce a notable lowering of the temperature, which is susceptible of application to a variety of practical purposes. The invention of a new description of air-tight cylinder, of new joints, a new stuffing-box, and a marvellous system of air-distribution have enabled M. Giffard to embody this principle and apply it to practical use. The result is a machine, which when driven by an ordinary steam-engine, consuming 1 kilog. of fuel per horse-power, per hour, will make 20 kilogs. of ice, or reduce 220 cubic metres of air to a temperature of 40° C. for each kilog. of fuel burned. If it is found that this air can be used dry or moist as required, the machine may be expected to find universal application in every branch of industry.

A curious proof of the frigerific power of the apparatus is afforded by the fact that, when the escape-pipe is opened, the cold air escapes in visible shape, like a puff of ordinary steam. The temperature of the escaping air is so low that it freezes the particles of moisture floating around, thereby producing the appearance of a steam jet.

Vegetable Scale-Preventive for Boilers.—CONSTANT patents (France) the following composition as a scale-preventive in steam-boilers. The specified materials are to be boiled separately in Seine water, and mixed in the proportions directed:—

Of 50 kilogs.	of	oak-bark,	boiled in	Seine water,	30 litres.
5	„	guiac wood	„	„	15 „
5	„	catechu	„	„	15 „
2	„	potash	„	„	4 „
1	„	sulphate of soda	„	„	2 „
10	„	molasses	„	„	15 „
10	„	zinc	„	„	10 „
5	„	log-wood extract	„	„	15 „
Mixture of soap, water, glycerine, and decoction of mazarine					10 „
					111 litres.

Revue Indust., 20*th Oct.* 1875.

New Method of Testing the Hardness of Steel.—This method, recommended by Dr. WALTENHOFEN, is based on the observed fact that, when a bar of steel is inserted within a magnetizing coil, one end is generally more strongly attracted than the other, a result which has been found to be due to difference of hardness in different parts of the bar.

The samples to be subjected to this test should be of one

length, say 10 centim. (4 in.), and about the same weight, say 20 grammes. The bar to be tested is suspended by a copper wire on a cork ring beneath one of the scales of a hydrostatic balance, the equilibrium of which is restored by weighting the opposite scale. For the water employed in determining specific gravities is substituted a magnetizing coil, 2 centim. in diameter and 10 centim. high, standing on end, so that one half the bar may be within it. A current of electricity is then passed through the coil, and draws down the balance. The opposite scale is weighted with sand to restore the balance. This done, additional weight is added, until the bar is detached from the coil. As this is a very delicate operation, it must be carefully performed. To avoid the friction of the bar against the inside of the coil, it is best to provide a glass lining for the latter, equal to its height.

Dr. Waltenhofen recommends a coil composed of six copper wires of 6 millim. gauge, covered with a double casing of woollen thread, forming twenty-four spirals, or 144 in all. The height of the coil should be 0·09 metre; the interior diameter 0·030 metre. With this a weight of 87 grammes will be required to overcome the attraction exerted by the coil on a bar of soft iron 10 centim. long. For a bar of tempered steel of the same dimensions 52 gr. will suffice. For steels of lower tempers the weights will be intermediate between these extremes. It is well to commence each series of experiments with a bar of soft iron, kept for the purpose as a standard. Steel that has once been used cannot be employed again, but iron demagnetizes as soon as the contact is broken.

The results will probably be found to vary with the size of the coil and the intensity of the current; *but, in every case, the attraction exercised by the coil will be in inverse ratio to the hardness of the steel. Stummer's Ingénieur, 1st Oct.* 1875, *from Dingler's Polytech. Journal.*

Domestic Steam-Engine.—M. ROSER, No. 8, Rue des Chaumettes, Paris, has just patented a very elegant and portable little steam-engine, admirably adapted for all sorts of domestic purposes and for a host of industries where small motive power only is needed, as in hand-turning, watchmaking, machine-sewing, stamping, embossing, hand-printing, and the like.

The generator consists of two concentric cylinders of iron plate, the inner containing a serpentine of sheet metal serving as a boiler, with the furnace underneath, whilst the space between the cylinders forms a steam-chamber. A feed-cistern surrounds the flue, so that the waste heat is utilized in raising the temperature of the feed-water. A spherical metal case incloses the safety-valve and steam-port.

These engines are made in various sizes, from ⅓ to 2 horse-power. A small one in the Maritime Exhibition, at the Palais d'Industrie, is of ½ horse-power, *i.e.*, its motive power is equal to that of two men. The generator is 2 ft. high and 14 in. in diameter, and by an ingenious disposition the serpentine presents a fire-surface of 9 square feet nearly. Steam can be got up in it within twelve minutes after lighting the fire, and the coke consumed when the engine is in full work costs 4 centimes (one halfpenny) per hour. This little engine drives a sewing-machine as well as a circular saw 15 in. in diameter. The invention appears particularly deserving of attention in establishments where sewing machines are largely used. One such engine would drive a dozen or fifteen machines easily, and serve as a stove for warming the work-room as well. *Les Mondes, 28th Oct.* 1875.

Improved Hydraulic Water Elevator.—With the remark that improved methods of utilizing wind and water power are amongst the most important benefits which it is within the power of science to bestow on agricultural industry, the ABBE MOIGNO directs attention to a new pumping-engine, driven by water, the invention of M. Rigolet, of St. Léger-sur-Dheune (Saône et Loire). The machine is in various sizes, from 1 to 4 *chevaux-vapeur.* Full particulars may be obtained from the inventor. *Les Mondes, 28th Oct.* 1875.

Comparative Cost of Steam Power.—According to "Ackermann's Gewerbezeitung," human labour costs, on an average, 90 times, electricity 70 times, and horse-power 10 times as much as steam-power.

Non-Conducting Lining for Steam Cylinders.—PESLIN patents the application of non-conducting linings to steam cylinders, to prevent loss of heat. In the drawing attached to the specification the cylinder is shown as lined with ground glass, and the bottom of the cylinder and the ends of the piston coated with enamel. Any material that is a worse conductor of heat than cast iron may be used instead of the glass. *Revue Indust., 10th Nov.* 1875.

§ 2. *Building, Decoration, &c.*

Artificial Stone.—PREUSSER, represented by Armengaud of Paris, patents a process for subjecting mixtures of sand and lime to the action of carbonic acid, in suitable apparatus, whereby the hydrate of lime becomes speedily converted into carbonate of lime resembling natural stone. *Bulletin de la Soc. Chim. de Paris, xxiv.* 6 *and* 7, 1875.

Movable Flange for Doors and Windows.—Under the (rather formidable) name of "plinthe-bourrelet mobile indépendant," BÉNARD, 10, Rue Oudinot, Paris, manufactures a very neat and elegant substitute for sandbags, list, and other old-fashioned appliances for the exclusion of draughts and damp—a strip of wood covered on the outer side with cloth, and held in its place by a couple of gilt studs. It forms an air-tight joint, and, once fixed, permits the doors or windows to be opened or shut as before without risk of displacement. *Les Mondes, 11th Nov.* 1875.

IMPROVED PORTABLE MASHING APPARATUS FOR POTATO-DISTILLATION.

THE "Oesterreichische Landwirth. Wochenblatt" recommends the portable apparatus represented in the accompanying figures, as the simplest and best yet introduced in Germany. It has been patented by R. Jahn, engineer, of Prague, and is designed more particularly for the distillation of potato-spirit. It may, however, be used for maize or corn as well, in combination with a Hampel or other cooler.

Figs. 1 and 2 give front and end views of the apparatus, which, it will be seen, consists of a vertical steamer surmounting a horizontal mash-tub.

In figs. 1 and 2, A is the mash-tub, a horizontal cylinder, in which the potatoes are reduced to wort by the action of arms

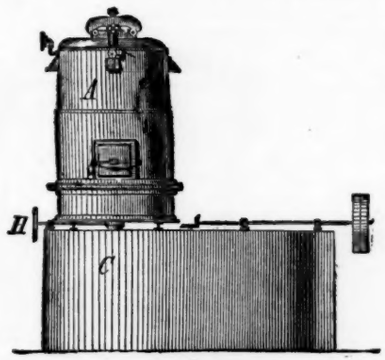


Fig. 5.

revolving with the axis C, which is worked by hand-power applied to its extremities, or by the strap-wheel D; B is the steamer; E is a man-hole for inspecting the interior thereof; F is a hinged lid, which lifts up to admit the potatoes; G is a valve for passing the steamed potatoes into the mash-tub; H is the escape-pipe for the condensation water; I is a pipe for running off the wort to the coolers; *a a* are the steam-cocks, *b b* the safety-valve; *c* the steam-gauge.

Figs. 3 and 4 show the interior arrangements. A is the steamer; B the mash-tub, here trough-shaped instead of cylindrical; D is the valve; E a horizontal grating; F a disintegrator; G, the revolving arms; L, the man-hole; M, the condensation water-pipe; N, the cock for running off the mash.

If desired, the steamers can be used alone, with any other form of mash-tub, as in fig. 5.

The apparatus is light and simple, and can easily be put up in the course of a few hours.

A steamer large enough to reduce 100 centners, or about 5½ tons of potatoes daily, costs 780 Austrian florins (£78). With mash-tub complete, the same-sized apparatus costs 1,500 florins (£150).

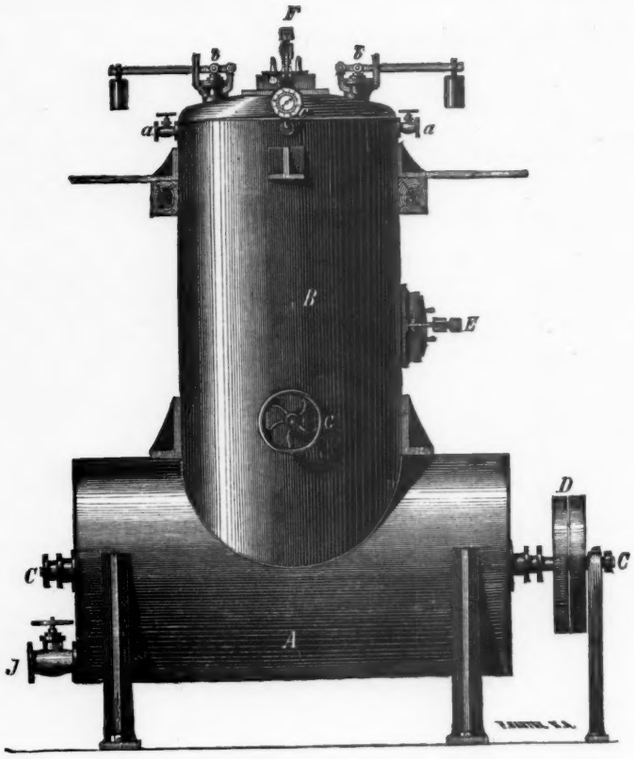


Fig. 1.

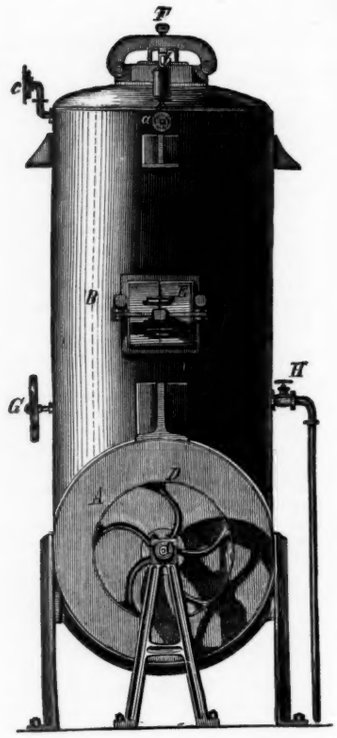


Fig. 2.

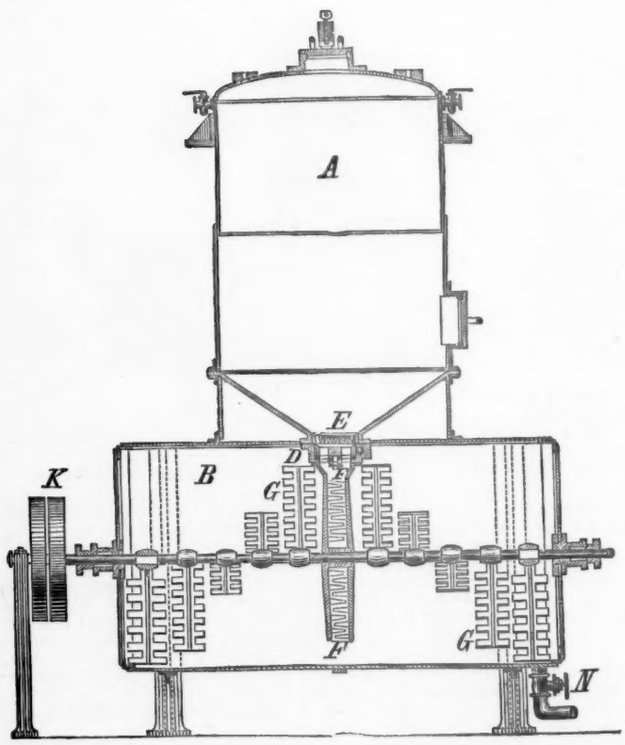


Fig. 4.

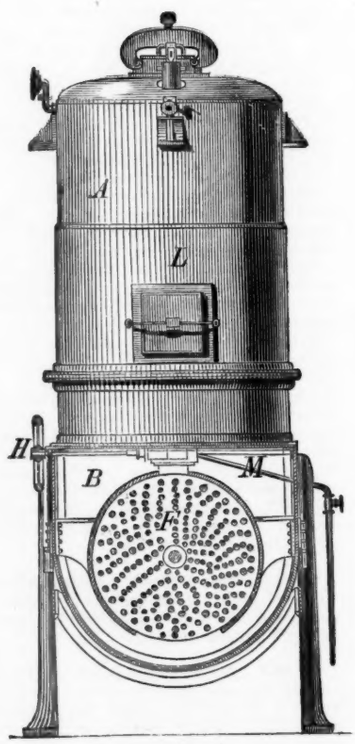


Fig. 3.

IMPROVED PORTABLE MASHING APPARATUS.

Chemistry applied to the Arts, Manufactures, &c.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF SOCIETIES, ETC.

§ 1. *Acids, Alkalies, and Salts.*

EXCRETION of Carbonic Acid by Animal Species.—In a note on the amount of carbonic acid excreted in the breath and perspiration by different animal species under the same conditions, and by the same species under different conditions, Dr. POTT states that the greatest amount of carbonic acid per 100 grammes of living weight is excreted by birds (4·93 grs. in six hours); next follow mammals (2·95 grs. in six hours); and then insects. Young animals excrete a proportionately greater weight than old ones. *Chemical News, from Centralblatt für Agriculture, Chimie.*

Carbonic Acid rendered visible by Sunlight.—A correspondent of "Les Mondes" writes, that, wishing to give his workpeople ocular proof of the existence of gas in the wine vats, he adopted the following plan:—A fine day was selected, with bright sunshine and no wind. A watering-pot was filled with the gas by holding it inside one of the vats, below the rim, for several minutes, so as to give time for the carbonic acid to displace the air. A sheet of white paper was then laid flat on the ground, and the carbonic acid poured upon it like water from the spout of the pot. The shadow of the gas, descending by its own weight, with a curling motion like smoke, was plainly perceptible on the paper. By keeping the nozzle of the spout so close to the paper that the nozzle and its shadow are 6 to 12 inches apart only, the shadow thrown by the upper portion of the gas becomes very dark, whilst the centre is brightly illumined by the concentration of the solar rays traversing the gas. The vintagers, who witnessed this simple experiment, were much astonished by the sombre depth of the margin of the shadow, and still more so by the luminous intensity of the central portion. They could then readily comprehend that a person entering a vat, even if the head be kept above the walls, runs the risk of drowning as in invisible water.

§ 2. *Metallurgy.*

Hard Solder.—FLETCHER, F.C.S., recommends a mixture of equal parts of copper and coin silver as a first-rate hard solder. In respect of fluidity and freedom from what is called "burning" if overheated, it is far superior to the old-fashioned alloy of silver and brass. It requires a rather higher temperature than brass alloy, but practically is quite as safe to use, as it will not burn and is as fluid as water, while there is no comparison between the soundness of the joints made with each. *Jeweller and Metal Worker, 1st Sept.* 1875.

Argentine.—Dr. KAYSER gives the following analysis of this composition, which is sold for silvering copper, brass, and iron: Ammoniate of silver 5·5, water 100, sal-ammoniac 6, hyposulphite of soda 10, and powdered chalk 10 parts; total 131·5. *Mittheilungen Bayerisches Gewerbe-Museums.*

Use of the Magnetometer in Searching for Iron Ore.—In a paper communicated to the Royal Swedish Academy of Sciences, Professor THALEN recommends the use in mineral surveys, for the detection of iron veins, of an instrument resembling the "Unifilar Magnetometer," now used for magnetic observations. It consists of a compass on a tripod stand, the case of which has a projecting arm carrying a deflecting magnet, and is provided with a plummet, spirit level, &c.[1] The area to be surveyed is divided, with the theodolite or otherwise, into squares of 100 yards side. At each of the angles, the magnetometer is set up, and the deflection duly ascertained. Stations giving like results are then connected on the plan by isodynamic lines. In most cases it will be found that these lines group themselves about two points within the area, one of greater and one of lesser deflection. An imaginary line connecting these points is called by Professor Thalen the "magnetic meridian of the area." Underlying it will be found the richest veins. Up to the present time this method has been found to give very satisfactory results.

[1] A description of the unifilar magnetometer, with instructions for use, will be found in the "Admiralty Manual of Scientific Enquiry" (London: Murray, 1871), pp. 96-7.

Graupener Antifriction Metal.—In 1874, the steam machinery at some of the Prussian royal mines, in Upper Silesia, was supplied with bearings formed of an alloy manufactured at the Mariaschein Tin-works, in Bohemia, under the name of "Graupen'er Lager-Metall." The results were eminently satisfactory. There was no heating, even at the highest speed, very little wear, and the consumption of lubricants was much less than with gun-metal bearings. *Zeitschrift für Berg, Hutten, u. Salinen-Wesen, xxiii. 1 and 2,* 1875.

Smitter-Léniau Metal.—LÉNIAU, of Paris, patents, under this name, a new white alloy, very malleable, easily fusible, unoxidizable, and well suited for all sorts of jewellers' work. It is composed of:—

Rose copper	720
Nickel	125
Bismuth	10
Zinc	95
Malleable iron	20
Tin	20
	990

The proportions may be varied according to circumstances. The copper, iron, and nickel are run down together first; then the bismuth is stirred in and the composition run into moulds. It is afterwards re-melted, the tin added, and again run into moulds.—*Bulletin de la Soc. Chim. de Paris, xxiv. 8 and 9,* 1875.

§ 3. *Dyeing, Calico Printing, Bleaching, Tanning, and Allied Subjects.*

Ruby Alizarine.—PALUN, of Avignon, patents the following process for preparing this dye:—Madder in the root or powdered, or madder flowers, after macerating in slightly alkaline water, are pressed and boiled in water containing 5 per cent. of ammonia, soda, or slaked lime. The precipitate so formed is washed on a filter until the alkaline reaction disappears. It is then treated with 60 per cent. of hydrochloric acid, and again filtered on wool and washed until the acid reaction disappears. Any remaining acidity can be neutralized with soda or lime. The mass is then pressed, dried, and ground to a fine powder. For sale it may be mixed with a certain quantity of carbonate of soda or lime. *Bulletin de la Soc. Chim. de Paris, xxiv. 6 and 7,* 1875.

Use of Cerium in Dyeing.—At a recent meeting of the Physical Society of Frankfort-on-the-Maine, M. BÖTTGER stated that the salts of cerium, particularly the bisulphate, have lately been used to some extent for dyeing, presumably to give with aniline salts an intense black on cottons. M. Böttger finds that by dipping cotton yarn alternately in a solution of some aniline salt acidulated with a little hydrochloric acid and a solution of bisulphate of cerium, and afterwards in a solution of potassium dichromate, a very beautiful black is produced. *Technologiste, Oct.* 1875.

§ 4. *Food, Water, and Sanitary Matters.*

Tellier's Cold-Producing Apparatus.—M. CHARLES TELLIER has written to the Academy of Sciences to say that his Cold-producing Apparatus (figured and described in the "Practical Magazine" for October, 1874) will shortly be submitted to a crucial test, in regard of its conservating powers. A steamer, the "Eboe," of 900 tons, has been purchased expressly, and will shortly be registered as a French vessel, and rechristened the "Frigorique." After fitting with the apparatus, she will start for La Plata with a full cargo composed of wine, beer, butter, cheese, yeast, hops, fresh vegetables,—in short, of everything that hitherto has been considered unfit for a tropical voyage. She will bring back, in like manner, a cargo of fresh meat, fresh fruit, green hides, silkworms' eggs, and other South American produce. *Les Mondes, 21st Oct.* 1875.

New Fertilizer.—According to the undermentioned journal, granite and porphyry (?) reduced to powder, are now extensively employed as fertilizers in the eastern departments of

France. Dr. SIEGLER states that daily experience confirms the belief in their efficacy, and that, were a cheap and expeditious method of pulverizing the materials available, a new era in agriculture would be inaugurated. *Stummer's Ingr., 15th Oct.* 1875.

Solar Ventilation. — DON JOSÉ VALLHONESTA, a Spanish engineer well known by his experiments in connection with the art of dyeing, proposes to utilize solar heat for purposes of ventilation. In place of the air being set in motion by mechanical means or by the direct application of artificial heat, currents would be induced by the concentration of the solar rays on metal roofing or on metallic chimney shafts. Of course the action would be intermittent, depending as it would on the time of day and the state of the weather. Auxiliary means of ventilation would therefore be requisite; but it is suggested that these need not materially interfere with the great saving of fuel which would attend the adoption of the method in suitable localities. *El Porvenir de l'Industrie, 7th Oct.* 1875.

Preserving Hops.—JUNG, of Fürth, patents, in Bavaria, a new method of preserving hops by keeping them in some non-oxidizing medium. On the supposition that the deterioration to which hops are subject in keeping is due to the oxidizing influence of the atmosphere, and that the methods commonly used, as sulphuring, drying, pressing, &c., are merely means of retarding such action, he considers this result would be more effectually accomplished by placing them in an atmosphere consisting of nitrogen, carbonic acid, or some other like gas. Carbonic acid is recommended as the cheapest.

The hops are packed in chests. The carbonic acid, generated by treating lime with sulphuric acid, is led into the upper part of the chest, and allowed to sink through the hops by its own weight, thereby displacing the air, which escapes at the top, the lid of the chest being left partly open for the purpose. When a sufficient quantity of carbonic acid has entered, the lid is shut down, and the chest made air-tight. It is asserted that the process costs no more than drying and pressing in the ordinary way.

In proof of the conservative powers of carbonic acid, it is stated, some fresh eggs were broken, and placed in cups, some being covered with a film of carbonic acid, and others left exposed to the air. The latter were rotten in four days, the former were sound at the end of three months. *Bayerisches Indust.- u. Gewerbe-Blatt., Aug.* 1875.

Pneumatic Malting.—This name is given to an improved process of malting, originated by the manager of a French brewery, M. GALLAND. It consists in driving air, of uniform temperature and saturated with moisture, through the grain at a speed just sufficient to carry off the carbonic acid generated in the malting process, and no more. Layers of barley 12 to 18 in. in depth can be thus treated, whereas in the ordinary way a depth of 4 to 8 in. is the maximum. A great saving of space is thus effected.

The malt-house is built of masonry set in cement, and is divided into closed, vaulted chambers, which should be sufficiently numerous to leave one chamber always vacant. The malting floor is of perforated iron plate, on which the grain is spread after steeping. A central air-shaft gives a continuous supply of fresh air, of a uniform temperature of 12° C. (53° Fah.), and terminal air-passages conduct the vitiated air to a chimney, the draught of which is regulated by a revolving fan. The air-passages have dampers to control the air-currents, and two coke ovens and a water-sprinkling apparatus provide for suitable degrees of warmth and humidity therein.

M. Galland allows 2 cubic metres of air for each square metre of malting-floor, per minute, or about 600 cubic metres of air per minute for twelve chambers. Experience shows that air that has been used may be employed over again by adding one-twentieth part of its volume of fresh air.

The advantages claimed for the process are—1. Economy of space; 2. reduction of labour by one-half; 3. absolute uniformity and regularity of malting all the year round; 4. avoidance of all risk of bruising and crushing the grain. M. Galland states that his experiments show that, where malt prepared by the old process costs 4 fr. per sack, by the new it will cost 2 fr. 12 c. only.

Professor Schwackhöfer, of Prague, writing on the subject in the "Präger Landwirthschaft Wochenblatt," observes that an idea of the saving thus rendered possible may be formed by remembering that in Austria alone 20,000,000 Wiener eimers (about 300,000,000 English gallons) of beer are brewed annually, requiring 4,500,000 centners, or over half a million tons of malt. In North and South Germany the consumption of malt is larger still. Professor Schwackhöfer adds that the process appears to be equally applicable to the preparation of fruit, tubers (as potatoes), and other materials for distillation. Here it would probably improve the quality of the article, as well as effect a saving of labour. *Bulletin de la Société d'Encouragement, July,* 1875; *Stummer's Ingénieur, 15th Oct.* 1875.

Preservation of Food with Compressed Gas.—In a communication addressed to the French Academy, M. ALFONSO-REYNOSO states that this subject (to which allusion has previously been made in our pages) has engaged his attention since 1873. He has succeeded in keeping fresh juicy meat (63 kilogs. of beef) perfectly sound and sweet for periods of 2 to 3½ months. When taken out of the apparatus it presented the appearance of ordinary butchers' meat, and kept much longer exposed to the air. Mutton so treated, when exposed to the air, dried very slowly, and kept good for an indefinite time. Meat so prepared can be used for all sorts of culinary purposes. When large joints of beef have been cut, after having been subjected to the process for six weeks, the juice ran out of them as out of fresh-killed meat. Meat kept in compressed carbonic oxide undergoes an alteration, assuming a very rich and brilliant colour. But in a high-pressure atmosphere of atmospheric air, or oxygen, or nitrogen, or hydrogen, no such result follows. *Comptes Rendus, lxxxi. 26th Oct.* 1875.

A New Sugar.—The officer commanding the Khedive's troops in the newly acquired territory of Darfûr, reports that he has lately received a present of sugar manufactured by the natives from the *flowers* of a plant called "huscha." Orders have been issued for further inquiries to be instituted respecting the article and the mode of preparing it.

Java Cinchona Bark.—The *Cinchona calysaya*, now cultivated in Java, differs considerably from the South American plant. The latter is rich in *quinine;* the former, generally speaking, contains no quinine, but a considerable quantity of *quinidine.* Dr. Vry showed, in 1869, that this alkaloid is not produced by the transformation of the quinine, but in some way is formed in the plant itself.

Hesse gives the following analysis of Java bark (*C. calysaya*):—

Quinidine	3·18
Cinchonine	0·16
Quinine and Cinchonadine	0·00
Amorphous bases	0·77
	4·11

Hesse repeated Zorn's experiments with hydrochloric acid without obtaining the chlorated alkaloid described by that chemist. The acid merely gave a crystallized hydrochlorate of quinidine, from which the latter was precipitated pure by the addition of ammonia. *Bulletin de la Soc. Chim. de Paris, xxiv.* 6 *and* 7, 1875, *from Annalen der Chimie u. Pharmacie.*

Jullien's "Refraichisseur."—This simple contrivance, patented by JULLIEN, 52, Avenue Daumesnil, Paris, is intended to supply a ready method of cooling beverages of all sorts without reducing them to a needlessly low temperature which may be injurious to the digestive organs. It consists of a cloth, which is wrapped round the bottle or other vessel to be cooled, and is kept constantly wetted with water from a small receptacle that fits over the neck of the bottle. The cloth imbibes the water by capillary attraction, acting on the same principle as the wick of a lamp, and the evaporation of the water produces the requisite reduction of temperature. To any part of France, Algeria, or the colonies, one of these *refraichisseurs* is sent, carriage free, by the inventor for 2 francs 50 cents. *Les Mondes, 28th Oct.* 1875.

Artificial Cooling of Large Volumes of Air.—MM. MIGNON and ROUART have communicated to the French Academy of Sciences the results of some experiments in cooling air by contact with the surfaces of refrigeratory liquids, together with an account of the practical application by them, at the Royal Candle Works, Amsterdam, of the principle thence deduced.

The apparatus employed in the preliminary experiments was a three-necked flask, in the bottom of which was placed a couple of inches of concentrated solution of chloride of lime in water. The flask could be stood, if required, in some refrigerating mixture. One neck served for the admission of atmospheric air; the second for its exit; the third held a thermometer to show the temperature of the solution within. To the right and left were placed other open flasks, containing siccatives, to show the effects of hydration on the air. Thermometers were also provided to show the temperature of the air on entering and leaving

the central flask; and an aspirator for driving the air. The experiments were frequently repeated, and the velocity of the air was constantly varied. The following were the chief results:—

Twelve litres of air were passed through the apparatus in one minute. The temperature of the chloride of lime solution was —7° C.; that of air on entering + 8° C.; on leaving — 4° C. Consequently 12° C. were lost in one minute.

Experiment repeated; velocity of air reduced to one-half. Same result.

Three litres of air passed through the apparatus in three minutes, *i.e.* velocity of the air was twelve times less than in the first experiment. Loss of temperature in the three minutes, 9° C.

It is thought that these contradictory results may be thus explained. The doubling of the rate of egress does *not* halve the duration of the contact between the air and the refrigeratory liquid. The duration of contact depends on the velocity with which the air traverses the liquid, which depends on differences of density, and is accordingly constant. A considerable reduction in the rate of outflow involves a notable loss by radiation. Assuming this view to be correct, the duration of contact between the air rising through a depth of 2 in. of refrigeratory liquid and this liquid may be calculated. The hydration of the air appeared not to affect the results in these experiments. In practice this would, of course, be altered.

Now, as to the practical application of the principle. The problem was to maintain, throughout the hot weather, a uniform temperature of about 12° C. (53° Fahr.) in one of the buildings of the Royal Candle Factory at Amsterdam. This building is 50·20 m. (166 ft.) long by 14·54 m. (48 ft.) wide, and 4·18 m. (14 ft.) high; and into it are daily introduced some 15,000 kilogs. of oil, at a temperature of 60° C., for crystallization into stearic acid.

As a refrigerating mixture, a concentrated solution of chloride of lime prepared with ammonia solution was used, which gave 60,000 negative calories per hour. The air was set in motion by a fan, at the rate of 20,000 cubic metres per hour, the capacity of the building being 3,051 cubic metres. For a refrigerating apparatus, a modification of the three-necked flask, enlarged to suitable dimensions, might, of course, have been used, but practical considerations led to a different arrangement. A large cylinder was employed, which was insulated as much as possible, and contained a number of transverse plates revolving with a central (vertical) axis between discs projecting from the cylinder walls. The refrigerating mixture was poured on the topmost plate, and, being carried by the centrifugal force of its rotation against the cylinder walls, was prevented from rising by the projecting discs, and so forced down to the plate next below, where the operation was repeated. In this way the rotation of the axis kept the interior of the cylinder constantly filled with a finely comminuted cascade of the cooling mixture. The air drawn from the heated building by the fan was driven through the cylinder, re-entering the building from above. From the 20,000 cubic metres, or 26,000 kilogs. of air driven through it hourly, the apparatus abstracted 26,000 × 0·23 × 10 = 59,800 calories. Practically the results were found perfectly satisfactory. During the first fortnight of last September, when the weather was exceptionally hot, the temperature of the huge building was kept steadily between 12° and 13° C.

It is noted that the chloride of lime becomes impoverished by use to some extent, owing to the absorption of a large amount of watery vapour from the heated air—a result that may be found of considerable importance in certain industrial processes. *Comptes Rendus, lxxxi. 18th Oct.* 1875.

Physic in Food.—Watercress has long had the popular reputation of being a powerful antiscorbutic. Probably, all the *Crucifera* equally deserve the title. M. DUPUY says that the plant contains an essential oil of which sulphur forms a constituent, and that he has also discovered in cress iodine, iron, a bitter extract, and phosphorus. He therefore adds these minerals to the soil, to increase the quantity in the plant, and then prepares a *succus*. He has established cress-gardens for the culture of this plant, in order, as he says, to "vegetalize" the minerals which give it such important properties. This reminds us that long ago an Italian writer proposed to obtain iodized milk for his patients by feeding cows on hay sprinkled with potassium iodide. It may be doubtful if the cows would like the flavour. More recently, an English writer has stated that the cows on the island of Ushant, off the coast of Brittany, feed principally on sea-weed, and that consequently their milk is particularly rich in iodine; and it is proposed that this milk be used for the cure of diseases benefited by iodine, as it does not produce the constitutional disturbance that often results from the admixture of iodine in other forms. Last of all, it has been reserved for a French physician to iodize eggs by electricity. The arrangement employed may be readily understood when we say that he conveys the iodine into the egg by what we may call electrolysis. By any of the above methods, physic may be put in the food of invalids without imparting any disagreeable flavour. *The Doctor.*

Mineral Waters for Cattle.—A severe case of cough in a thorough-bred horse, following on a violent attack of influenza, has been cured by the administration of sixty flasks of Ems water, two flasks daily. Ems water has also been used successfully in cases of bronchitis in sheep. Wiesbaden and Seltzer waters have been employed for liver complaint and yellows in dogs, and soda-water in cases of chronic swellings in cattle, with very beneficial results. *Schlessische Landw.-Zeitung.*

§ 5. *Fuel, Heating, Illumination, &c.*

Influence of Certain Colouring Matters on the Sensitiveness of Photographic Plates.—VOGEL states that haloïd combinations of silver are rendered sensitive to certain colours of the spectrum by mixing them with certain colouring matters which absorb those colours. Naphthaline red renders bromide of silver highly sensitive to the yellow rays, and chloride of silver still more so. Fuchsine acts differently. On bromide of silver it has the same effect as naphthaline red, but the sensitiveness to yellow light of chloride of silver is very slightly altered by it, whilst, on the other hand, the sensitiveness for violet is powerfully increased. The influence of colourless substances employed in the same way varies. Morphine when mixed with iodide of silver increases the sensitiveness of the latter for blue and violet, and also for green; on bromide of silver it has no effect. Pyrogallic acid acts in like manner. The action of a given substance on any particular salt of silver affords no criterion, therefore, of its action on any other salt. But, that such substance should act on a salt of silver, it must be soluble in alcohol and ether, and fulfil certain conditions besides. It must be an absorbent of the particular luminous rays to which it is intended to render the collodion sensitive; it must have the property of fixing bromine or free iodine; and it must not have any reaction on nitrate of silver, so as not to interfere with the preparation of the sensitive plates. *Deutsche Chem. Gesellschaft., viii.* 1875.

Improved Reflector for Lighthouses, &c.—Professor BALESTRIERI, of Naples, has invented an improved reflector for lighthouse illumination. It resembles that of Fresnel, but its catoptric powers are reported to be much higher. Experiments in the Piazza del Popolo and at the Villa Borghèse, at Rome, showed that an ordinary 2-in. lamp, placed in the focus of the reflector, gave a beam of light of sufficient intensity to render small print easily legible at a distance of 1 kilometre (1100 yards nearly). *Les Mondes, 11th Nov.* 1875.

§ 6. *Miscellaneous.*

Ferruginous and Magnetic Particles in the Atmosphere.—M. G. TISSANDIER states that an examination of over 400 samples of aerial dust, collected from the most widely different sources, has shown that a percentage of magnetic particles is invariably present. These particles are essentially iron. Their minuteness has prevented their being tested for nickel and cobalt. Under a microscopic power of 500 diameters they are found to range themselves under five different shapes:—*a*, greyish amorphous fragments, $\frac{1}{18}$ to $\frac{1}{10}$ millimetre in diameter; *b*, black mammiform particles, $\frac{1}{100}$ to $\frac{1}{100}$ millimetre in diameter; *c*, fibrous particles of like size; *d*, perfectly spherical particles, $\frac{1}{100}$ to $\frac{1}{100}$ millimetre in diameter; *e*, the same furnished with a small neck or tail.

Particles of ferruginous dust from various terrestrial sources were subjected to a like examination, with the following results:—

1. Magnetic iron ore reduced to a fine powder presented the appearance of grains with a smooth fracture, quite different from the foregoing.

2. Iron ores of various kinds, sesquioxide of iron, &c., reduced to powder, contained no particles that were attracted by the magnet.

3. Rust from iron to powder gave amorphous particles with smooth fractures.

4. Rust from iron surfaces exposed to the air or submerged in sea water or in fresh water, when reduced to powder, presented a greater or less percentage of magnetized particles, all of which had the form *a*.

From this M. Tissandier concludes that the mammiform and globular particles found in aerial sediment and in the residua of rain water are of cosmical origin, and have probably been disseminated in the atmosphere by the bursting of meteorites in an incandescent state. This view is confirmed by the result of the following experiments. Very fine iron filings poured through a hydrogen flame, and received on a china plate, under the microscope were found to have assumed the form of globules with or without tails, as in *d* and *e*; where the fusion had been incomplete they presented mammiform or fibrous shapes. *Comptes Rendus, lxxxi.* 14, *4th Oct.* 1875.

New Colour Thermoscope. — Captain HERMANN HESS, of the Austrian Engineer Staff, has devised a very simple form of thermoscope for temperatures between 70° and 100° C. (158° to 212° Fah.) The action of the instrument depends on the rapid discoloration of a mixture of iodized potassiate of mercury with sulphate of copper, when exposed to a temperature above 70° C., a fact, we believe, first noticed in the pages of the "Scientific American." A solution of iodized quicksilver in iodide of potassium is mixed with a solution of sulphate of copper. A vermilion-red precipitate forms, from which the liquor is decanted, the precipitate being afterwards washed, first with a solution of hyposulphite of soda, and afterwards with distilled water. Lastly, it is dried over sulphuric acid in a desiccator. Captain Hess considers that it is then represented by the formula $Cu_3J_2.2Hg.J_2$. It is unaffected by water or spirits of wine; may be mixed with a varnish composed of shellac dissolved in proof spirit, and employed as paint; and wet or dry is of a bright vermilion red. When exposed to a temperature of 70° C. or upwards, it turns a deep chocolate brown almost instantaneously. If the temperature does not exceed 100° C., it quickly resumes its original hue on cooling to about 70° C. again. At temperatures above 150° C. (302° Fah.) the preparation softens and decomposes. Laid in the form of a thick coat of paint on a strip of clean paper, glass, or china, &c., the preparation furnishes a very convenient thermoscope for the temperatures above mentioned, which will often prove useful in circumstances where it would be difficult or impracticable to employ a thermometer, as in testing the temperature of bearings of all kinds, of steam and hot-water pipes, of tar cauldrons, bake-ovens, &c., &c. A sort of colour-gauge may be added by placing a stripe of vermilion paint, the exact shade of the preparation when cool, on one side of the thermoscope, and a stripe of umber of the shade it assumes between 70° and 100° C. on the other, so as to afford standards of comparison for the changes of colour undergone by the portions coated with the preparation. *Stummer's Ingénieur, 1st Oct.* 1875, *from Mittheilungen über Gegenstände des Artillerie u. Genie-Wesen*, No. 9, 1875.

Sudden Fractures in Glass.—HAGENBACH states that the liability of some glass wares to fracture suddenly, without obvious cause, when exposed to small changes of temperature, and which depends on unequal degrees of expansion on the inside and outside of the objects, may be detected by examining them with polarized light, when they exhibit a more or less brilliant display of prismatic colours. In glass that has broken in this way, the peculiarity is generally observable. On the other hand, the examination of a large collection of glass vessels, of good temper, which had stood the test of long wear, proved that very few indeed displayed any traces of colour when viewed by polarized light. *Poggendorf's Annalen, No.* 7, 1875, *from Basler Natursf. Gesellschaft.*

Internal Parasites.—Earth-eating in Animals.—In an interesting paper in the "Veterinarian" for October, Dr. SPENCER COBBOLD, M.D., F.R.S., suggests that the curious propensity for "earth-eating," often observed in elephants and horses in India and Ceylon, and in horses and other cattle in Australia and elsewhere, is probably a consequence of irritation caused by internal parasites, in support of which view he adduces a variety of evidence from different quarters. "Almost every succeeding day," he adds, "supplies me with fresh evidence in reference to the great influence that *parasites* exert in the production of diseases affecting both mankind and animals—the latter, indeed, from the highest to the lowest degree of organization. But I cannot, of course, expect that those who have not studied the question of parasitism as long and patiently as I have will at once agree with me."

Expeditious Method of Preparing Straw Pulp for Paper.—M. DIETRICH has proposed a new and expeditious method of treating straw pulp, so as to reduce the quantity of chloride of lime required to bleach it. Soda-ley, no matter how strong, seldom extracts all the soluble matter from vegetable fibre; when the latter is soaped afterwards, it again parts with a notable quantity of colouring matter. In bleach-works where soaping is practised, the consumption of chloride of lime or chlorine is proportionately less. One of the chief objects in treating straw with soda-ley in paper-making is to dissolve the outer casing of silica, and so lay bare the fibre. It is probable that this result would be accelerated by the addition of ammonia, the solvent properties of which have been pointed out by Struckmann, by Liebig, and more particularly by Pribram. According to the latter, silica once dissolved by ammonia remains in a state of solubility after the ammonia has evaporated. The foregoing considerations have suggested the process referred to.

A mixture is made of 500 kilogs. chopped straw, 75 kilogs. caustic soda, 75 kilogs. soft soap, 15 kilogs. liquid ammonia, sp. gr. 0·970, in 1,500 litres of water. The mass is boiled in a suitable iron vessel. The lid is then luted down, steam of 4 atmospheres is introduced, and the contents are kept stirring under pressure for the space of four hours. Afterwards they are washed with warm water, beaten, and bleached in the ordinary way, allowing 50 to 60 kilogs. of chloride of lime and 10 kilogs. of sulphuric acid to 500 kilogs. of stuff. Lastly, the pulp is pressed into cakes containing 60 per cent. of water, and is then ready for the mill. With materials in the above proportions, 325 kilogs. of pulp of unexceptionable colour and quality were obtained. Rye straw was found to give the best results. The boiling should not be unduly prolonged, or the stuff will get "burned," and be unfit for use. *Technologiste, Sept.* 1875.

Improved Leather Bandages for the Feet.—Improved forms of leather socks and bandages for weak or malformed feet, some of which are figured in the undermentioned journal, have been patented (in Denmark) by Petersen, 22, Norgesgade, Copenhagen. *Industrie Tidende* (*Copenhagen*), *19th Sept.* 1875.

Celluloid.—This substance has lately been manufactured in the United States as a substitute for ivory and vulcanized rubber. It is composed of camphor and fulminating cotton, is very hard, and takes a very fine polish. Considering the dangerous character of the composition, it is not surprising to learn that the manufactory in New Jersey, where it was prepared, has been reduced to ashes by an accidental explosion, causing the loss of one life, and destruction of property to the amount of 150,000 dollars.

"Thao."—At a recent meeting of the Industrial Society of Rouen, M. HOUZEAU presented a specimen of "thao," forwarded by the Commissioners of the Exposition Permanente des Colonies Françaises. The substance in question appears to be a species of lichen, which abounds in Japan and Cochin-China. It is a white substance resembling gelatine, insoluble in cold water, but soluble in boiling water, to which it communicates a jelly-like aspect. It has the singular property of solidifying *one hundred times its weight of water*. One kilog. of thao dissolved in water gives 100 kilogs. of a magma which has been successfully employed at Lyons in glazing silk. It is thought that it would form a useful dressing for many textile fabrics, being impermeable to water. Thao sells retail in France at 10 fr. per kilog. A dépôt for the sale has been established at 66, Rue de Bondy, Boulevard Haussmann, Paris.

Essence of Bergamot.—The authorities of Reggio, Calabria, offer a prize of 2,000 lire (francs) for the best apparatus for extracting this essence. The conditions are strength and cheapness in the apparatus itself, combined with capacity for producing the largest quantity of essence in the shortest time, without detriment to the colour, purity, and fragrance of the extract. The competition is under the patronage of the Italian minister of agriculture. *El Porvenir de l'Indust., 21st Sept.* 1875.

The Electric Telegraph as a Seismoscope.—M. RIVET states, on the authority of M. Destieux, Telegraph Superintendent at Fort de France, Martinique, that on 6th Sept. last and the succeeding days, when the island experienced repeated earthquake shocks, each shock was preceded by a very marked disturbance of the galvanometer of the electric telegraph.

At 10.25 A.M. on 6th Sept. the needle was much disturbed, and eventually fixed itself, pointing towards the earth. At the same time the wires of the earth-connection were found to be so highly charged with electricity as to produce a discharge when touched with the hand. At 10.53 A.M. the first shock was felt, and the needle immediately resumed its ordinary position. At 12.17 P.M. it was again disturbed, the disturbance increasing until 2.45 P.M. At 3 P.M. followed another very violent shock. At 4 P.M. the needle, which had resumed its usual position, was

again disturbed. At 6 P.M. followed another shock. At 6 A.M. next morning the needle was at rest. At 2·25 P.M. it was strongly deflected earthwards; a shock followed at 3 P.M. Similar phenomena preceded all the subsequent shocks.

M. Rivet suggests that a timely warning of approaching shocks, which hitherto has been unattainable, might thus be supplied. The galvanometer must not be insulated, or the phenomena will not be exhibited. That at Fort de France is connected by a conductor formed of three wires, one iron, one copper, and one zinc, with a mass of iron, weighing about 2 cwt., sunk 8 ft. beneath the surface of the ground. *Comptes Rendus, lxxxi.* 18*th Oct.* 1875.

Practical Literature.

A DICTIONARY OF SCIENCE, LITERATURE, AND ART.

THE rapid growth of human knowledge in every department during the past few years is shown in the most striking manner by the great number of new and revised editions of works on various subjects that daily come before us; and these three goodly volumes, covering as they do almost the entire field of the knowledge of this nineteenth century, bring its development before our minds with almost startling effect. More than a generation has passed away since the first edition of this work appeared, and during that time Science has been marching with enormous strides. The subjects of Biology, Zoology, Palæontology, Geology, Physical Geography, Chemistry and Physics, Astronomy, &c., have all received contributions of immense value, and have grown to what seems colossal proportions when compared with their condition at the time of which we speak: a new language almost has been coined in which to express the increase of our knowledge in connection with them; the wisdom of thirty-five years ago has been merely the stepping-stone by which men have risen to higher things; and it may be that we are yet upon the threshold—the portals of Science are open, but we have not yet entered into her spacious halls. The next generation, entering upon the fruit of the labours of the present, may penetrate into some of her mysterious chambers and will wonder that we remained so long at the door; but of them, as of our scientific men of this and the past generation, it will be said, that they are only as children gathering the pebbles by the sea-shore, while the great ocean of knowledge lies unexplored before them.

But it is not for us to concern ourselves here with the future of Science. Its importance and growth at the present is certainly enough to occupy us; but it is only natural that a glance at the past, with so powerful a realization of the present as these volumes before us, should lead us to project our thought somewhat into the future.

In order, then, to adequately exhibit the results of the scientific research and general knowledge of the present day, a thorough and complete revision of the work before us has been needed, and the result of this revision has been, we may say at once, the production of a work of admirable and exhaustive fulness of information upon almost every conceivable branch of knowledge.

The design of this work is to give in a convenient form an abstract of the principles of every branch of Science, and an explanation of the various terms ordinarily met with in Literature and Art. If this want were felt nearly half a century ago, it must be a still more urgent one at the present time. It is not every one who can possess himself of the enormous Encyclopædias, which are growing year by year, and edition by edition, until they become almost a very library in themselves, and at the same time the man of science, the literary man, the artist, or the general reader, cannot be content with a Dictionary treating of his own special subject; he frequently requires information on topics with which that may not deal. Hence the necessity for grouping together all that will come under the comprehensive title of Science, Literature, and Art, and making for this a Dictionary apart.

It is obvious that, in the production of a work of this kind, no such end could be achieved as that of making definitions clear, correct, and concise, ensuring a method of treatment which, though brief and compendious, should be neither flimsy nor superficial, without securing the aid of gentlemen of undoubted and adequate knowledge and ability in their various departments. This end has been most worthily attained, the various departments of Agriculture, Architecture, History, Language, Logic, Mythology, and General Literature, Astronomy and Meteorology, the Biological Sciences, Botany, Chemistry, Physics, Geology, Physical Geography and Hydrology, Law, History, Mathematics, Mineralogy, Music, Navigation, Painting and the fine arts, Political Economy, Printing, Bibliography, &c., Theology and Ecclesiastical Literature, having each been intrusted to men whose names are well known in connection therewith; without being invidious, for to name all would almost extend our review into a catalogue of the contributors, we may refer to such names as Professor Thorold Rogers, Dean Merivale, Dr. Frankland, Professor D. T. Ansted, as guaranteeing the excellence of the work and the soundness of the choice of the editors in selecting them.

The revision of the present edition, the last having been published in 1865-67, has been chiefly confined to the articles on General Chemistry, Physics, Law, and on General Literature. The new Chemical Notation has been introduced, and the modern ideas of chemical action have received the attention that their importance deserves. The results of the more recent investigations with reference to the nature of the science have been included, and that general revision in other departments rendered necessary by the events of the past ten years has been carefully and thoroughly performed.

As might be expected from a work which has had the advantage of the joint editorship of the Rev. Mr. Cox, great attention has been paid to the derivations which follow each word in the Dictionary; they profess in no degree to trace the words to their original head, important as this task is, but simply to give the immediate source from which they have been brought into our language; terms of doubtful origin being indicated as such, and, where the views held are different with different philologists of acknowledged standing, both are given. The references to works bearing on the various subjects treated of in the book are a valuable feature, not so much on account of the number of such references, as on account of their being simply references to the best authorities.

In concluding this notice, no phrase of commendation occurs to us so suitable as the hackneyed one, that no library should be considered complete without the work; but, of all the books of which this has been said, of none can it be said with more truth and justice than of the present.

[1] *A Dictionary of Science, Literature, and Art, comprising the definitions and the derivations of the Scientific Terms in general use, together with the History and Description of the Scientific Principles of nearly every branch of human knowledge.* Edited by W. T. Brand, D. C.L., F. R. S. L. E., late of Her Majesty's Mint, and the Rev. George W. Cox, M. A., Author of "A History of Greece," "The Mythology of the Aryan Nations," &c. New Edition Revised. In three volumes. London: Longmans, Green, and Co. 1875.

ASTRONOMY, GEOLOGY, CHEMISTRY, MAGNETISM AND ELECTRICITY.[1]

ONE of the most remarkable characteristics of the present day is the increasing desire for scientific knowledge among all classes of society, and the energetic manner in which our great men of science are exerting themselves in every direction to feed and encourage it. Nearly every publishing season brings us the announcement of some fresh series of Primers, Text Books, Manuals, or what not—in most cases published at a price which puts them within the reach of all—having for its object the diffusion of scientific knowledge; and, so far as we can judge, nearly all of them find a ready public. This is no doubt a most gratifying state of things, not only to the enterprising publishers who find their ventures so well received, but to all who are interested in the spread of education, and, above all, of scientific education throughout the country. But it is not without its disadvantages. It has been said that, "in the multitude of counsellors there is wisdom," there can be no doubt that in the multitude of books confusion is sometimes apt to arise: and, moreover, one result of this lavish profusion of intellectual provender is the promotion of that smattering of knowledge which is so destructive of real intellectual "grip," and which does not educate in the true sense of the word. This

[1] *Astronomy.* By Andrew Findlater, LL.D. London and Edinburgh: W. and R. Chambers. 1875.

Geology. By James Geikie, F.R.S., Author of "The Great Ice Age." London and Edinburgh: W. and R. Chambers.

Chemistry. By Alex. Crum Brown, M.D., D. Sc. London and Edinburgh: W. and R. Chambers.

Magnetism and Electricity. By John Cook. London and Edinburgh: W. and R. Chambers.

tendency is, we believe, becoming daily more marked in our schools and educational establishments, and the only remedy which we can see for the evil (for an evil it undoubtedly will be, if it has not already become one) is a special education for the special walk in life, the importance of which, except in certain professions, has not yet been sufficiently recognized by the young man who hopes to make himself a master of the trade, business, or profession, to which he may devote himself.

The fact is, then, that the acquisition of scientific knowledge is becoming daily of greater importance; and, while we think it but right to point to the evils which may result from too omnivorous a tendency in acquiring it, it is impossible not to recognize that some general knowledge of the principles of science is an absolute necessity, and we therefore welcome any real addition to our educational literature which may aid in its diffusion.

The four little volumes before us are the first instalment of a series of Elementary Science Manuals projected by the firm of W. and R. Chambers—so well known for the sound and popular educational literature which it has been the medium of giving to the world—and it is edited by Dr. Andrew Findlater. The Manuals are designed with the twofold object of serving as Manuals for Self-instruction and as Text Books in Schools—and the preface to the series justifies this double purpose by stating that "the mode of treatment naturally adopted in what is to be studied without a teacher, so far from being a drawback in a school-manual, will, it is believed, be a positive advantage. Instead of a number of abrupt statements being presented, to be taken on trust and learned, as has been the usual method in school-teaching, the subject is made, as far as possible, to unfold itself gradually, as if the pupil were discovering the principles himself; the chief function of the book being, to bring the materials before him, and to guide him by the shortest road to the discovery. This is now acknowledged to be the only profitable method of acquiring knowledge, whether as regards self-instruction or learning at school."

To adapt them for school use as well as to enable the self-instructor to test his mastery of the subject, a series of questions is given at the end of the volumes, each numbered with reference to the section or division to which it corresponds.

We have carefully examined the books which have reached us, and they are in every way what we should have expected from the names of their authors—clear and well arranged—leading the student by easy stages from the simplest to the higher and more complex aspects of the subjects; and we have no doubt that the series will meet with the recognition it deserves.

We are a little puzzled to know how it is that, in a book bearing the date of the present year, both on the title-page and the preface, the transit of Venus of 1874 is referred to as a prospective event; and, although we are glad to note that the latest discoveries and deductions of scientific men are readily availed of, yet we think that it would have been best if no reference had been made in works which are avowedly of an elementary nature to theories which are still *sub judice*. Such references occur more than once in the series, and it seems to us that it is certainly needless to burden the student with any details upon such theories when the ascertained facts of the science are being put before him.

DESIGNING VALVE GEARING.[1]

THE author of this book, seeing that the formulæ for the due proportionment of the various parts of valve gearing propounded by our mathematicians, necessarily involve so much abstruse and complicated calculations as to be of little or no assistance to most of those who need to use them, has for his object to show that "starting with the application of the 31st Proposition of the 3rd Book of Euclid to the subject of valve gearing, as first suggested by Professor Zeuner, it is possible to obtain certain geometrical constructions which without involving a single mathematical calculation, or indeed any other operation that can (? cannot) be performed with a rule and compasses, will yet enable us to obtain results practically as accurate as those deduced from mathematical formulæ, but with this further advantage, that whatever errors may chance to occur in the construction must at once make themselves apparent."

It is quite true, as our author states, that "the rule of thumb" practice which is so often resorted to results frequently in much loss of time and labour, to say nothing of the loss of fuel and steam which arises from defective arrangement; but, after all, we cannot regard his work in any other light than that of a modification or improvement of the rule of thumb principle to which exception is so justly taken. We hold it to be a necessary qualification for the position of foreman in an engine-constructing workshop, that such formulæ as have been given by our best authorities should not be so far beyond them as to be unavailable, but in the present state of the education of our mechanics and engineers the work may perhaps be accepted as possessing some utility, and, while recognizing the benevolent intentions of our author, we shall be glad to see the time arrive when his work will be no longer necessary.

[1] *Designing Valve Gearing.* By Edward J. Cowling Welch, Memb. Inst. Mech. Engineers. London: E. and F. N. Spon. 1875.

STRUCTURE AND PRESERVATION OF THE VIOLIN.[1]

SOME two or three years ago there was to be seen at the South Kensington Museum a loan exhibition of ancient violins, which a popular writer on the subject characterized as in all probability such a collection as was never before brought together at any one time. There might have been seen instruments of fabulous worth, of rare manufacture, and of historic renown. The unique "Messiah" Stradiuarius, together with other specimens of that famous maker's art, some exquisite specimens of the best workmanship of Guarnerius Amati and a host of well-known makers were there, and to the lover of the instrument the cabinets containing these precious specimens were a boundless delight. Not alone, however, were there to be found such priceless gems as these. Between the rude and strange Viols de Gamba, and such-like instruments, and the finished specimens to which we have referred is a wide gulf; but here were shown the various stages through which this perfection had been reached, and it is this historical aspect of the exhibition which is recalled to us when reading the pages of the work before us.

It was not before the last half of the sixteenth century that the violin proper was developed from the enormous variety of rude and uncouth stringed instruments that had previously existed, and for more than one name is the honour claimed of having been the first maker; we believe that it lies between two—Testator, called Il Vecchio, of Milan, and Dinffoprugcar, who is said to have made the instrument very early in the century. Be that as it may, the violin now to us, in the words of a writer to whom we have before referred, "reigns the prince of all instruments, and in the hands of a Paganini or a Joachim the joy and wonder of a civilized world." It is with the object of preserving some of the masterpieces of violin manufacture from the desecration which so often befalls them in the hands of unskilful "doctors" that a very large portion of the little work before us is written, and by giving not only a popular, but a practical description of the instrument as well, to deter ignorant meddlers from marring the beauty of the instruments which may come into their hands.

The book deals with the construction of the violin and its congeners, and gives some drawings to aid the descriptions; but it is by no means intended to make an amateur into a manufacturer, rather is it to give the amateur an idea of what really constitutes a good instrument by teaching him to recognize the points which make up the perfect whole of a well-constructed violin.

Brief accounts of the most celebrated makers and of the most widely known instruments are also given, and a most important chapter is the one on the repair, preservation, and method of bringing out the tone of instruments—the author proving himself to be well acquainted with the mechanical as well as theoretical laws which govern the production of good musical effect.

The literary faculty is one which is not unfrequently absent in minds which have always moved in an absolutely practical groove, and this may, perhaps, account for some peculiarities of style, which in a book of greater literary pretensions would have called for some severe remarks. The translator, carefully as he has supplemented the original with many useful notes, has not to our minds rendered the book into the smoothest English. Notwithstanding these drawbacks, however, the work is a valuable one to all lovers of the violin, and we are glad to see that it is growing in favour in this country, the present being the third edition which has appeared.

[1] *A Treatise on the Structure and Preservation of the Violin, and all other Bow Instruments, together with an account of the most celebrated makers, and of the genuine characteristics of their instruments.* By Jacob Augustus Otto, Instrument maker to the Court of the Grand Duke of Weimar; translated from the original with additions and illustrations, by John Bishop (of Cheltenham). London: Robert Cocks and Co. 1875.

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